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The American Journal of Roentgenology

Edited by P. M. Hickey, M. D.

VOL. II Published December, 1915 Nos. 11 and 12

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THE AMERICAN JOURNAL OF ROENTGENOLOGY

Editor, P. M. Hickey, M.D., Detroit

VOL. II PUBLISHED DECEMBER, 1915 Nos. 11 and 12

A BRIEF REVIEW OF THE PROGRESS OF ROENTGENOLOGY IN THE PAST DECADE

ADDRESS BY THE PRESIDENT, ALFRED L. GRAY, M.D., RICHMOND, VA. MEETING OF A. R. R. S., ATLANTIC CITY, SEPT. 22-25, 1915.

IT seems fitting on this, the second decennial anniversary of Roentgen's discovery, that we at this session pause to review briefly the progress made in the last decade in the application of the science and art of roentgenology. In assuming for myself this task, I shall attempt to be consistent and will not long delay the treat that is in store for you from the speaker of the evening.

Let us consider this subject: first, as regards apparatus; secondly, from the standpoint of diagnosis; and thirdly, that of present day roentgen therapy.

Just ten years ago this Society marveled at a slide shown by one of its members, which depicted a child's chest with the heart at perfect rest. The plate had been made in one-tenth of a second. To-day it is rather the rule than otherwise to picture the adult heart in either systole or diastole with its borders sharp. At that time the average adult chest required an exposure of a period beyond the possibility of respiratory control, and a lung lesion was gross indeed that lent itself to roentgen diagnosis. Even so recently as that the aim of the manufacturers was to supply the highest possible voltage, and the thirty-six-inch coil made for one of us was to be the *summum bonum* of generators. The idea slowly permeated the brains of some of the more astute that perhaps voltage beyond a certain maximum was not necessary and that current quantity might be a more important factor than so much current pressure. They devised and constructed a large primary coil of a comparatively low voltage, but capable of transmitting through a tube a greatly increased milliamperage. Thus the keynote of speed in roentgenography was struck and the rapid and powerful apparatus of to-day has been developed by easy stages.

The next forward step in generator construction was the interrupterless transformer, the product of the skill and ingenuity of a member of this Society; but with this new obstacles confronted us. The tubes that had withstood the heaviest currents for a considerable time now cracked at the cathode neck and punctured at the focus point under the intense heat caused by the increased current quantity. The inverse rings of the low tube, when running under coil excitation, no longer served as a danger signal, and the tube expense well nigh exhausted the treasury. The generator manufacturers had outstripped the tube builders. The increased production of tungsten (fusing point 3000° C) with its manifest advantage over platinum (the fusing point of which is 1775° C) enabled the tube manufacturers to overcome fairly effectually the

target-puncturing difficulty, and by modifying the shape and structure of the cathode terminal, as well as by the employment of other sources of electrons than air, the evil of cathode necks breaking from over-heating has ceased to be a common disturbing factor.

Perhaps the most noteworthy single advance in tube construction since the invention of the focusing cathode was the hot-cathode tube, another product of American research given us less than two years ago, which, by reason of its stability and susceptibility of almost perfect control, has rendered possible technique in roentgen diagnosis and therapeutics beyond the dreams of the most sanguine.

Since our last meeting another stride has been made in tube construction and there has been placed on the market a tube having means for easily and rapidly raising or lowering its vacuum, and by reason of its hydrogen electron source is capable of prolonged usage under heavy currents with a minimum of heat production. Thus the necessity of a multitude of tubes of different vacuum characteristics is avoided and in place of the space-consuming racks and tube shelves another hospital ward or waiting-room may be fitted up so that the roentgenologist may be spared the direful consequences of more than one-third the prescribed hygienic breathing space.

Let us give our attention for a few moments to advances in diagnosis. *Pari passu* with the development of generators and tubes has been the widening of the field of diagnostic possibility. Speed and uniformity of action on the part of the apparatus rendered possible sharp delineation, on the plate, of objects usually in motion. The dangers of unprotected roentgenoscopy had begun to be realized, and the method was for a time almost entirely abandoned. The speedy exposures then becoming possible permitted the screen to be supplanted, except in rare instances, without serious loss. One of the first applications of rapid roentgenography was to determine the presence or absence of tubercles in the lungs, and, as a natural sequence, stereo-roentgenography of the chest was soon possible. The addition to our armamentarium of a usable intensifying screen rendered possible a picture of objects whose motility is wholly beyond voluntary control.

Many of us will recall the pride with which our lamented colleague, Dr. C. L. Leonard, exhibited, at the meeting here in 1909, a plate showing the two boluses passing down the esophagus, and aptly entitled by him, "When the Swallows Homeward Fly." It is difficult to realize that practically all our knowledge of pathological conditions in the alimentary canal, roentgenologically speaking, limited and imperfect still, has been obtained since that time. It is true that the foundation had been laid both in America and in Europe long previously, but the beginning of real scientific investigation of gastro-intestinal abnormalities has been well within the past decade.

What of our knowledge of the accessory sinuses and the mastoid, of pyelography, ureteral kinks and deformities, abnormalities of the pituitary fossa and even cranial fractures, of the presence of gall-stones, of diagphragmatic hernia, of the course and origin of soft-tissue sinuses and fistulæ? All these and many more pathological conditions have come into the field of roentgenologic possibilities within the past few years.

What shall I say of roentgen therapy? Compare your present program with those of the meetings of a few years ago. Select for instance that of the meeting of 1911 when I had the pleasure of your visit to Richmond. Of twenty-five papers, only two pertained to therapy; to-day, of forty, ten are devoted to treatment alone. Why this great increase in ratio? Is it due to our special energies to secure papers for this symposium? Not at all, we have been

forced to lend our efforts to the other phases of roentgenology to prevent an over-plus on the therapeutic side.

Roentgen therapy has had its vicissitudes. Almost every ill to which mankind is subject has been the object of roentgen therapeutic experimentation. Those of us in search of the truth were forced to admit its narrow therapeutic limitations, and until the advent of tubes that would hold up under heavy currents deep therapy had to a great extent been abandoned. To-day, notwithstanding the limitations, the roentgen rays have an established field in the treatment of disease that few, if any, other known agent may enter. How simple and rational is the cross-fire method of treating neoplasms! Why was it not uniformly adopted in the earlier days? Experiments in filtration, the results of which were shown first to this body in 1905, were perhaps responsible for the investigation that has placed deep therapy on its present firm basis. Little, however, was actually accomplished until tubes were constructed that would maintain a uniform radiation under definite current conditions for such a period as was necessary to secure the required dosage through the intervening tissues and filters. How complete and lasting will be the symptomatic cures effected by deep therapeutic methods as practiced to-day, time alone can determine.

The past year has been the first in the history of roentgenology that has failed to bring much that was new and valuable from our colleagues abroad. Their labors have been, of necessity, chiefly confined to the applications already well known. They are toiling for humanity under circumstances, which God forbid we may be called upon to experience! There are absent from our midst familiar faces; men active in this Society, whose fertility of mind and untiring energy have contributed largely to the interest of our meetings. Let us bid them God-speed in their work and trust that an ever watchful Providence may shield them and permit them speedily to rejoin us in our labors of peace. Our energies should be redoubled and greater inspiration impel us to do greater things when we consider that the world is looking to this body to keep up the science of roentgenology.

AMERICAN ROENTGEN RAY SOCIETY

PROCEEDINGS OF THE SIXTEENTH ANNUAL MEETING HELD AT THE CHALFONTE HOTEL, ATLANTIC CITY, N. J., SEPTEMBER 22-25, 1915

First Day—Morning Session

The Society was called to order at ten o'clock by the President, Dr. Alfred L. Gray, of Richmond, Va.

The minutes of the 1914 meeting were called for and the Secretary, Dr. Manges, referred to the report of the minutes published in the July, 1914, issue of the *American Journal of Roentgenology*.

On motion of Dr. Pancoast the minutes were accepted as published.

The Chairman announced that at the opening of each session during the meeting the Society would consider business matters first, and that only members of the Society would be permitted to attend at this time. He announced further that members were requested to register at the Treasurer's desk and on doing so would be given an official badge.

Dr. George C. Johnston, Chairman of the Executive Committee, read the applications for membership on hand at that time, and announced that the Committee would report on these applications later.

Dr. James T. Case, Chairman of the Publication Committee, read the following report, which, on motion, was received and ordered published in the Transactions:

To the President:

With the approval of the Executive Committee, your Publication Committee makes the following report:

While recognizing the development of our Journal from a quarterly to a monthly journal within a few years, with a progressive improvement in appearance and scientific merit—a progress due almost wholly to the laborious effort of Dr. Preston M. Hickey, entirely without compensation, we now feel that the time has arrived for a change in the business methods of handling the Journal. After one consultation between the Editor, Executive Committee and this committee it has been decided to place the business management of the Journal in the hands of Mr. Paul B. Hoeber, medical publisher of New York City. Dr. P. M. Hickey will continue as Editor-in-Chief with the collaboration of a staff of seven roentgenologists. Of the seven, this committee appoints Dr. Geo. E. Pfahler, Dr. J. S. Shearer and Dr. Geo. C. Johnston with the recommendation that these three and the Publication Committee, to be elected this session, choose the remaining four.

[Signed] James T. Case, Chairman;
E. H. Skinner, Sec'y.

Dr. Johnston, on behalf of the Executive Committee, recommended the appointment of a committee of three, said committee to revise the Constitution and By-Laws.

After some discussion, Dr. Johnston moved that such a committee be appointed. The motion was seconded and carried.

The Chair appointed on this committee Drs. W. H. Stewart, A. W. Crane, and Fred. C. Zapffe. (Dr. Crane, being subsequently elected President of the Society, withdrew from this committee, and appointed Dr. A. L. Gray.)

Dr. F. H. Baetjer called attention to the great loss sustained by the Society through the death of Dr. George H. Stover.

Dr. Dunham moved the appointment of a committee to draft suitable resolutions, and have them spread on the minutes. Seconded and carried.

Whereas; a beneficent Providence has taken away Dr. George Henry Stover; a roentgen colleague of forceful enthusiasm and an energetic pioneer in his chosen field, and

Whereas; it was our pleasure to welcome him each year, to esteem his presence, and to profit by his scientific contributions, therefore be it

Resolved; that the American Roentgen Ray Society pause for a period of this annual session to honor the memory of Doctor George Henry Stover of Denver, and further,

Be it resolved; that this Society convey its sincere sympathy to his family.

By the Committee.
Dr. F. H. Baetjer
Dr. Kennon Dunham
Dr. Edward H. Skinner

The Chair appointed Drs. Skinner, Dunham and Baetjer.

On motion, the Society suspended business for ten minutes to commemorate Dr. Stover.

During this time Dr. Skinner read a brief biographic sketch of Dr. Stover which he had prepared, and, on motion, this sketch was ordered published in the *American Journal of Roentgenology*. Other members of the Society spoke feelingly of Dr. Stover, mentioning his influence on the progress of roentgenology and the growth of this Society.

At the end of the ten minutes the scientific program was taken up. The first paper on the program was read by Dr. Fred. C. Zapffe, Chicago. It was entitled "The

Teaching of Roentgenology in Undergraduate Medical Schools."

Dr. Lewis Gregory Cole, of New York City, followed with a paper on "The Scope and Method of Teaching Roentgenology."

Dr. H. K. Pancoast, Philadelphia, discussed "Experiences in Roentgenologic Teaching."

These three papers were discussed by Drs. Baetjer, Dunham, A. M. Cole, Dieffenbach, Johnston, Zapffe, Cole, and Pancoast.

On motion of Dr. Zapffe, duly seconded, the Chair appointed the following committee on Teaching of Roentgenology in Undergraduate Schools: Drs. Baetjer, Pancoast, L. G. Cole, Bissell and Percy Brown.

Dr. Byron C. Darling, of New York City, then read a paper entitled "Oral Sepsis as a Focus of Infection."

Dr. A. M. Cole, Indianapolis, followed with a paper on "Dental Roentgenography."

The discussion on these papers was participated in by Drs. LeWald, Dachtler, Bissell, Skinner, Johnston, Hammond, Case, Dunham, Darling and Cole.

The Society then adjourned until 2 P. M.

Afternoon Session

The Society reconvened at 2 P. M., with the President, Dr. Gray, in the Chair.

The following papers were read in symposium:

"A Plea for Conservatism in the Treatment of Closed Fractures from a Roentgenologic Standpoint," Dr. S. B. Childs, Denver.

"Some Causes of Error in the Roentgen Diagnosis of Bone and Joint Conditions," Dr. Roland Hammond, Providence, R. I.

"The Value of the Lateral View of the Hip," Dr. P. M. Hickey, Detroit.

"Schlatter's Disease," Dr. E. H. Skinner, Kansas City.

These four papers were discussed by Drs. Cotton, W. H. Stewart, Zapffe, Baetjer, Childs, Hammond.

Dr. Amedee Granger, of New Orleans, then read a paper entitled "The Use of Oxygen in Cystography, with Preliminary Report on the Use of Oxygen in Pyelography."

"Pyeloscopy" was the title of a paper read by Dr. W. F. Manges, of Philadelphia.

These two papers were discussed by Drs. Selby, Crane, W. H. Stewart, Granger and Manges.

The Society then went into Executive Session.

On motion of Dr. Johnston, seconded by Dr. Case, Professor J. S. Shearer was nominated for Associate Membership. The motion was carried.

Dr. Johnston then moved that Mr. W. D. Coolidge be made an Honorary Member of the Society. The motion was seconded by Dr. Case, and carried.

The Society then adjourned until 10 o'clock, Thursday morning.

Second Day—Morning Session

The Society was called to order by the President at 10 o'clock.

Dr. Johnston, Chairman of the Executive Committee, read the following applications for membership, which had been approved by the Committee:

Ball, Clarence Franklin, Rutland, Vt.
Borzell, Francis Franklin, Philadelphia, Pa., 900 E. Westmoreland St.
Carr, Gladys Lydia, Lynn, Mass., 125 Ocean St.
Cleaver, Henry A., Wilmington, Del., 1007 West St.
Cook, Philip Howard, Worcester, Mass., 771 Main St.
Epler, Crum, Pueblo, Colo.
Gerber, Isaac, Providence, R. I., 259 Benefit St.
Kinney, Lyell C., Los Angeles, Cal., 1007 Merchants Nat'l Bank Bldg.
Moore, Alexander Berkley, Rochester, Minn.

O'Connell, Andrew Edward, Worcester, Mass., Slater Bldg.
O'Brien, Frederick Wm., Brockton, Mass., 12 Cottage Place.
Stewart, Chas. Wesley, Salt Lake City, Utah, Walker Bank Bldg.
Strother, Paul Morgan, Lynchburg, Va.
Taft, Augustus Robert, Charleston, S. C., 105 Rutledge St.
Tyler, Albert Franklin, Omaha, Neb., 507 City Nat'l Bank Bldg.
Watkins, William Werner, Phoenix, Ariz.
Waters, Charles Alexander, Baltimore, Md., Johns Hopkins Hosp.
Zulick, Jay Donald, Philadelphia, Pa., 1321 Spruce St.

On motion, the Secretary was instructed to cast the ballot of the Society for the election to membership of those named above.

The Secretary did so, and these applicants were declared duly elected to membership.

Dr. Johnston moved that the Secretary furnish each member of the Society with a certificate of membership. Seconded by Dr. Dunham.

Dr. Hickey moved as a substitute that this matter be referred to the Executive Committee. Seconded. Carried.

Dr. Johnston moved the adoption of the following resolution, seconded and carried:

Whereas, we, the members of the American Roentgen Ray Society, assembled, on this twenty-second day of September, Nineteen Hundred and Fifteen, in Atlantic City, N. J., for our sixteenth annual meeting, miss the familiar faces of Dr. Dodd, Dr. Luger, Dr. Pirie, Dr. Eager and Dr. Wilson, active members who are now in their professional capacity serving with the British forces;

Be it therefore RESOLVED, that we extend to these members our hearty greeting, together with our most earnest hope for their continued health and safety,

WHEREAS, by this act, we are reminded of our honorary members, Dr. Albers Shönberg, Dr. Mackenzie Davidson, Dr. Hall-Edwards, Dr. Haenisch, Dr. Holzknecht, Dr. Klynens and Dr. Schwartz, and our corresponding member, Dr. Humphries,

Be it therefore RESOLVED, that we extend to each of these and, through them, to roentgenologists generally, in their several countries, our greeting; our hope for their present and continued freedom from personal disaster; our pride in the essential neutrality of the Science-art which calls each of us, and which, even in these dark days, reaches out always to help and never to harm; and our confident anticipation of the day when, relieved from the restraint of these direful times, we shall resume that intercourse which, heretofore, has brought us so much not only of profit but of pleasure.

Be it RESOLVED also that these resolutions shall be spread upon our minutes, printed in an early number of the *American Journal of Roentgenology,* and that our secretary be requested to undertake to forward printed copies of the same to each of the above-mentioned members.

Dr. Hickey then addressed the Society briefly, asking for coöperation of the entire membership so as to make possible the monthly publication of the *American Journal of Roentgenology,* of which, he said, heretofore only ten numbers per year had been issued. He also stated that the Society was negotiating with a New York publisher to assume the publication of the *Journal.*

The scientific program was then taken up, the first paper being read by Prof. J. S. Shearer, of Ithaca, entitled "The Physical Aspect of Roentgen Ray Measurement and Dosage."

Dr. W. D. Coolidge, Schenectady, read a paper entitled "A Summary of Physical Investigation Work in Progress on Tubes and Accessories."

Dr. E. W. Hull, Schenectady, by invitation, read a paper entitled "Roentgen Ray Spectra."

Dr. L. G. Cole, New York City, read a paper entitled "New Apparatus."

These four papers were discussed by Drs. Caldwell, Snook, Dunham, Shearer and Coolidge.

The Society then adjourned until 2 P. M.

Afternoon Session

The Society reassembled at 2 P. M., with the President in the Chair.

Dr. G. W. Grier, Pittsburgh, read a paper on "Fluoroscopic Bronchoscopy," which was discussed by Dr. Johnston.

Dr. Kennon Dunham, Cincinnati, read a paper entitled "Lungs," and Dr. A. B. Moore, Rochester, Minn., read a paper on "The Roentgenographic Diagnosis of Metastatic Malignancy in the Lung," prepared by himself and Dr. R. D. Carman.

The discussion on these two papers was participated in by Drs. Manges, L. G. Cole, Pfahler, Boggs, Hickey, Childs, Dachtler, Case, D. R. Bowen, Crane, Austin, Newcomet, Dunham, and Moore.

Dr. A. W. George, of Boston, then read a paper entitled "Roentgen Study of Gall-Stones."

This paper was discussed by Drs. Case, Pfahler, L. G. Cole, W. H. Stewart, and George.

Dr. H. W. Van Allen, Springfield, Mass., read a paper entitled "Easy and Accurate Pelvimetry by the Roentgen Ray."

Dr. D. R. Bowen, Philadelphia, contributed "Laboratory Notes."

The Society then adjourned until 8 P. M.

Evening Session

The President called the Society to order at 8 P. M.

Dr. Wm. L. Rodman, Philadelphia, delivered an address entitled "The Value of Roentgen Rays in the Diagnosis of Gastric Diseases."

The President, Dr. Alfred L. Gray, then gave "A Brief Review of the Progress of Roentgenology in the Past Decade."

The Society then adjourned until the following morning.

Third Day—Morning Session

The Society was called to order at 9:30 by the President.

Dr. Pfahler moved that Drs. Shearer and Coolidge be made members of the Committee on Standards. Seconded and carried.

Dr. Hickey moved that all papers read before the Society be the property of the Society. Seconded and carried.

Dr. Pancoast moved that the revision of the Constitution to be prepared by the committee appointed for that purpose be published in the *American Journal of Roentgenology* soon enough before the next meeting so that all members might familiarize themselves with the proposed revision. Dr. D. R. Bowen amended the motion by asking to add that a transcript or proof of the revision be sent to each member of the Society. The amendment was accepted by Dr. Pancoast, seconded and carried.

The Chair here announced the following Nominating Committee: Drs. F. S. Bissell, L. Jaches, and J. H. Edmonson.

Dr. Frank S. Bissell, Minneapolis, then read a paper entitled "The Roentgen Symptomatology of Pulmonary Tuberculosis."

Dr. Pancoast then moved that Major Williams, of the United States Army, who was present, be extended the privileges of the floor. Seconded and carried.

The following papers were then read in symposium:

"The Comparative Value of Roentgen and Radium Radiation in Therapeutics," Dr. W. S. Newcomet, Philadelphia.

"Roentgen Deep Therapy and Radium by Emanation," Dr. A. F. Holding, New York City.

"Radium in the Treatment of Mucous Membrane Lesions Supplemented by Mod-

ern Roentgen Therapy," Dr. Russell H. Boggs, Pittsburgh.

The discussion on these papers was opened by Dr. Pancoast, and continued by Drs. Dieffenbach, Dachtler, Holmes, Johnston, Newcomet, Holding.

The Society then adjourned until 2 P. M.

Afternoon Session

The Society was called to order by the President at 2 P. M.

The following papers were read and discussed jointly:

"The Treatment of Exophthalmic Goiter by Roentgen Therapy," Drs. J. D. Zulick and George E. Pfahler, Philadelphia.

"Recent Results in the Treatment of Menorrhagic and Uterine Fibroids," Dr. Sidney Lange, Cincinnati.

"The Treatment of Malignancy. Description of New Therapeutic Apparatus," Dr. Geo. C. Johnston, Pittsburgh.

"The Cause and Prevention of Constitutional Symptoms Associated with Massive Doses of Deep Roentgen Therapy," Dr. Geo. E. Pfahler, Philadelphia.

"A Method of Preventing Unpleasant Symptoms Following Deep Roentgen Ray Treatment," Dr. Sidney Lange, Cincinnati.

The following joined in the discussion: Drs. Baetjer, Dunham, Stevens, Pfahler, Lange, Johnston.

Dr. L. T. Le Wald, New York City, then read a paper on "Studies in the Normal and Pathological Anatomy and Physiology of the Digestive Tract of Children."

Dr. W. H. Stewart, New York City, followed with a paper entitled "Roentgen Diagnosis of Obscure Lesions of the Gastro-intestinal Tract."

The Society then adjourned until 8 P. M.

Evening Session

The Society reconvened at eight o'clock, with the President in the Chair.

The following papers were read:

"New Roentgen Evidence in the Early Diagnosis of Early Gastric Carcinoma," Dr. A. W. George, Boston.

"Syphilis of the Stomach," Dr. L. T. Le Wald, New York City.

"Roentgenologic Diagnosis of Duodenal Ulcer," Dr. R. D. Carman, Rochester, Minn.

"The Duodenum, With Special Reference to Lesions Beyond the First Portion," Dr. James T. Case, Battle Creek, Mich.

On motion, the discussion was postponed until the next session, and the remainder of the evening was given over to the exhibition of lantern slides and the narration of cases.

Adjourned.

Fourth Day—Morning Session

The Society was called to order at 9:30 by the President.

The Report of the Treasurer was called for and read by Dr. Reu. It was referred to the Executive Committee for audit.

Dr. Johnston, on behalf of the Executive Committee, presented a resolution endorsing the establishment of a National Medical Examining Board.

"Recognizing the benefit to be had to the individual practitioner desiring to practice medicine in its various branches in the United States of America and the benefit that may be derived from a standardization of medical examination to secure uniformity in future requirements for admission to practice medicine in the United States. Also that the national government may in the event of expansion of its medical service accept candidates for its medical reserve corps without further examination. *Be it resolved*, that the American Roentgen Ray Society at its 16th annual meeting at Atlantic City, N. J., do hereby endorse the establishment of a National Medical Examining Board for these purposes.

"That a copy of this resolution as adopted by the American Roentgen Ray Society, be

furnished the secretary of the National Medical Examining Board."

On motion of Dr. Pfahler, seconded by Dr. Boggs, the resolution was adopted unanimously.

Dr. D. R. Bowen presented the report of the Exhibit Committee.

Dr. Pfahler moved a vote of thanks to the committee, recommending that its suggestions be adopted. Carried.

Dr. Thos. S. Stewart, Chairman of the Badge Committee, made his report.

After much discussion, Dr. Baetjer moved that the report be referred back to the committee, with instructions to reconsider the whole matter, and report next year. Seconded and carried.

Dr. Gray here announced that as the result of the ballot for election of a member to the Executive Committee, Dr. D. R. Bowen was elected, and it was so declared.

Following remarks made by Dr. Johnston, Dr. Pfahler moved that hereafter attendance on the meetings of the Society be confined to members and their guests. Seconded and carried.

At this juncture the Nominating Committee presented the following report:

President, A. W. Crane, Kalamazoo.

Vice-Presidents, W. B. Bowman, Los Angeles, and A. P. Gibbs, Columbia, S. C.

Secretary, W. F. Manges, Philadelphia.

Treasurer, W. A. Evans, Detroit.

Member, Publication Committee, Dr. Geo. C. Johnston.

Librarian, H. W. Dachtler, Toledo.

On motion, duly seconded, the nominees were declared duly elected to the offices named, the Secretary having been instructed to cast the ballot of the Society for their election, which he did.

Drs. Le Wald and Boggs were asked to conduct the President-elect to the Chair.

Dr. Crane briefly thanked the Society for the honor conferred on him, and pledged his continued support and coöperation in carrying on the work to the best interests of the Society.

Dr. Gray continued to preside.

Dr. A. W. Crane, Kalamazoo, then read a paper entitled "Appendicitis Simulating Cholecystitis where the Cecum is Congenitally Arrested in the Subhepatic Position."

This paper, and those read by Drs. George, Le Wald, Carman and Case, were discussed by Drs. L. G. Cole, Pfahler, Baetjer, Manges, Johnston, Dunham, Le Wald, Stewart, George, and Case.

Dr. G. M. MacKee, New York City, read a paper entitled "The Roentgen Ray in Diseases of the Skin."

Dr. John H. Edmonson, Birmingham, read a paper entitled "Treatment of Epitheliomata."

Dr. Hammond, the new Chairman of the Executive Committee, reported the Committee was not yet ready to announce the place of next meeting. He further announced that the Committee had audited the Treasurer's books and found them to be correct.

On motion, a vote of thanks was extended to the Local Committee.

The Society then adjourned *sine die*.

WILLIS F. MANGES,
(Sec.)

Resolutions adopted by the American Roentgen Ray Society upon the Death of

Dr. George Henry Stover

WHEREAS: a beneficent Providence has taken away Dr. George Henry Stover, a Roentgen colleague of forceful enthusiasm and an energetic pioneer in his chosen field, and

WHEREAS: it was our pleasure to welcome him each year, to esteem his presence, and to profit by his scientific contributions, therefore be it

RESOLVED: That the American Roentgen Ray Society pause for a period of this annual session to honor the memory of Doctor George Henry Stover of Denver, and further

BE IT RESOLVED: That this Society convey its sincere sympathy to his family.

By the Committee.

DR. F. H. BAETJER

DR. KENNON DUNHAM

DR. E. H. SKINNER.

A LIFE SKETCH OF DOCTOR GEORGE HENRY STOVER

IT is probably given only to small groups of colleagues who are welded together by an invisible Force to know each other in true values.

George Henry Stover, who was a member of the American Roentgen Ray Society for twelve years, had the characteristic energy of the pioneer and the influence of this fearless enthusiasm was frequently displayed in our midst.

In justice to the friends of his colleagues it must be said that Dr. Stover's early and sudden death was due to apoplexy, having suffered two previous attacks and having carried a high blood pressure for years.

Dr. Stover was found dead in his room at a hotel in Baltimore during his visit to that city for operative relief of lesions upon the hands.

While he carried the scars and the painful evidences of pioneer roentgen research it was a generous Providence that cut him off before these marks of scientific martyrdom claimed his body.

During a short life Dr. Stover made a deep impression upon Colorado medical life. He was an energetic supporter of organized ethical medicine, was at one time president of the Denver Medical Club and editor of the Denver Medical Times. These may be cited as incidents in the life of an enthusiastic roentgen consultant who enjoyed the allegiance of his confreres and the confidence of a large clientele.

He was elected Dean of the Denver and Gross Medical College at the early age of thirty-eight and was instrumental in the merging of this independent school with the University of Colorado in 1911.

In the course of troubles with roentgen lesions upon his hands and an increasing blood pressure Dr. Stover sought relaxation in Hawaii. His characteristic restless energy was displayed again when he became interested in the relief of the lepers at the Molokai Colony. He revisited this place often and for long periods. He established and maintained a roentgen installation here in an attempt to evolve a roentgen cure for the hopeless lepers. He became vitally interested in the welfare of the lepers' children who are taken from their parents early in life and raised in government schools and convents.

Dr. Stover was wonderfully affected by the lure of these Pacific Islands. It seemed to grip his very soul in a Stevensonian manner. Many will recall his vivid description of Hawaiian life and the glorious climate.

His love for Hawaii even found poetic expression, for among his papers these verses were discovered:

ISLES OF PEACE.

On the lanai of my bungalow
I dream away the hours;
All day the sweet, soft breezes blow,
Rich with the scent of flowers.

By day the sun shines warm and bright,
And "liquid sunshine" showers;
A thousand birds sing with delight
From out their leafy bowers.

Above me tall palms wave and sway
To the trade-wind pulses bending;
Lantana bloom, hibiscus gay,
In the tropic picture blending.

The surf rolls smooth at Waikiki,
Slow, soft, warm and inviting,
And rainbow colors fill the sea,
World-weary eyes delighting.

Above, the clouds float gently by
With mother-of-pearl tinting,
And out afar, where sea meets sky,
Are white caps, sunkissed, glinting.

Soft comes the tropic brief twilight,
Vague shadows cover the lea,
But silvered soon, as the moonlight
Dances in across the sea.

The reader of these verses, without an acquaintance with Dr. Stover, would hardly judge that force and energy were really his essential characteristics. He will be remembered in the roentgen world for his

convincing declaration upon the rights of the roentgenologist as a consulting expert rather than a purveyor of *x*-ray negatives.

His scientific abilities are acknowledged in the publication of the following bibliography:

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E. H. S.

A SUMMARY OF PHYSICAL INVESTIGATION WORK IN PROGRESS ON TUBES AND ACCESSORIES

By W. D. COOLIDGE

THE following is a résumé of some of the *x*-ray investigation work which is in progress in our laboratory.

Radiographic Work Requiring the Sharpest Possible Definition.

Conditions to be met in the Tube.—For this purpose, the first and most important desideratum in a tube is that it shall give the greatest possible *x*-ray intensity from a given sized small focal spot, for the use of a small focal spot imposes upon the tube a correspondingly small energy-input limitation, and this extends the time during which immobility of the part to be radiographed must be maintained.

To get the largest allowable energy input from a given sized focal spot, the following conditions must be met:

(a) The distribution of energy over the focal spot must be uniform.

(b) Heat must be removed from the focal spot as rapidly as possible.

The Cathode.—So far as (a) is concerned, the design of the cathode is all-important. Its effect is best studied experimentally by making *x*-ray pinhole camera pictures of the focal spot with various types of cathode.

A convenient method of making such pinhole camera focal-spot pictures is as follows: Take a square sheet of lead, say a sixteenth of an inch thick and of the right size to take the place usually occupied by the diaphragm in the tube stand. Make a conical depression in the center with a machinist's prick-punch, or other suitable tool. With a knife remove the tiny prominence produced in this way on the back of the lead plate, and then, with a pin or small drill open the hole to the desired size, say 0.02 inches in diameter. (If the hole is too large the focal spot picture will lack sharpness, and if it is too small, the required time of exposure will be needlessly long.) Put the lead plate and the tube in place in the holder and lay the photographic plate on a table below. The size of the focal spot picture can be varied at will by raising or lowering the tube holder. If it is to be of natural size, the distance from plate to pin-hole should be equal to that from pin-hole to focal spot. If it is desired to study the focal spot in greater detail, it is well to make the former distance twice the latter, which will give a twofold magnification.

It is a good plan to make two exposures, one of which is much longer than the other. The long exposure will then show the full extent of the focal spot, and the shorter one will show the distribution of energy over it. (In the case of gas-filled tubes, one should use the same current and voltage as are to be employed in regular work, for with this type of tube the size of focal spot varies greatly with the vacuum, being smaller the harder the tube is. With a hot-cathode tube, on the other hand, the size of focal spot is always the same regardless of the current and voltage employed.)

No conclusion concerning uniformity of distribution of energy can be drawn from the focal spot picture, unless care is taken to guard against over-exposure, for otherwise even a very bad distribution will appear uniform. This is shown by the upper pair of focal spot pictures in Fig. 1. The right-

hand one was exposed 3 seconds and the other 25. These are twice natural size.

One interesting type of cathode is shown in Fig. 2. The focusing device is a hemispherical bowl, and the filament spiral, instead of being convex outward, is concave, with the same radius of curvature as the bowl, and is located in the center and in the surface of the latter. Except for a small hole in the center, this gives a focal spot which shows a very nearly uniform distribution of energy and which is also very sharp and clean-cut at the edges. It is reproduced (again in twice natural size) in Fig. 1, the lower pair.

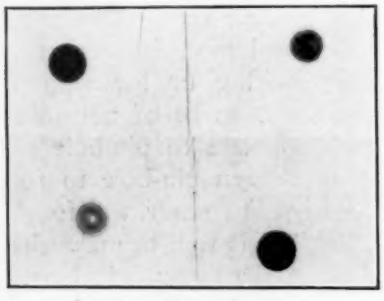

FIG. 1.

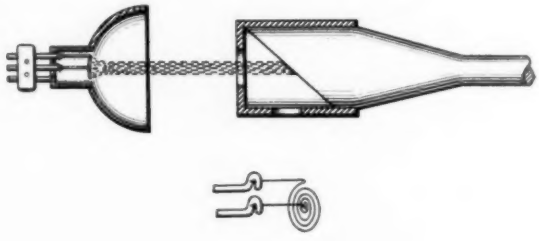

FIG. 2.

Target Design.—In connection with (b), various modifications of the target have been tried. The most obvious experiment was perhaps to try the copper-backed tungsten target such as is used in the gas-filled tube, for this brings copper, which has three times the heat conductivity of tungsten, close to the focal spot.

For a long time we were not able to make this experiment with the hot-cathode tube for the reason that we did not know how to exhaust it, to the required high degree of vacuum, with anything but tungsten or molybdenum electrodes. We finally learned how to do this and then made up two tubes, one with a copper-backed and the other with our regular all-tungsten target, taking care that the focal spot should have the same size in both. (This was subsequently checked by the *x*-ray pinhole-camera-picture method.) The tubes were run on a definite voltage for a definite time, with a definite current. The focal spot was then inspected to make sure that melting had not taken place. The current was then raised successively to higher values until the focal spot was finally melted, sufficient time being allowed between experiments for the target to cool.

For exposures of 3 seconds or less, starting cold, there appeared to be no difference in the two targets, or at any rate not more than the experimental error. The experiment is of course a little crude, but not so much so as one might at first think; for it can be repeated as many times as desired. (This is made possible by the fact that the bright shiny area which has been melted at the focal spot may be made to take on a dulled or frosted appearance by operating the tube even for as short a time as a minute with an energy input which is safely below that sufficient to cause melting. Having frosted the surface in this way, there is of course no trouble in again finding how much it takes, starting cold, to melt the focal spot.)

For 30-second exposures the copper-backed target was able to carry about twice as much energy as the all-tungsten target. This difference was due merely to the greater heat capacity of the heavy copper-backed target, and could have been eliminated by the use of a larger tungsten target.

For still longer exposures the tables were

turned, and the advantage was all with the all-tungsten target. This was of course due to the fact that it is not permissible to let a copper target get above a dull red heat, as otherwise it volatilizes badly and deposits on the bulb.

The experiment showed that a sufficiently large all-tungsten target would do anything that could be done with the present standard copper-backed target. (It was moreover free from the above mentioned limitation of the latter.)

The question naturally arises as to why copper with its three-fold greater heat conductivity does not assist more in getting heat away from the focal spot. The reason is this, that the tungsten disc in the standard copper-backed target is so thick (about 2.5 millimeters). The only place where high heat conductivity is important is in the immediate neighborhood of the focal spot and this position is in either case occupied by tungsten. Copper could be made to help if the thickness of the tungsten button could safely be considerably reduced. But if this is done the copper, back of the focal spot, melts. This melting of the copper is accompanied by expansion and this bulges out the tungsten at this point. Upon cooling, contraction of the copper takes place and an empty space is left between the tungsten and the copper at the focal spot. When the tube is again used, the tungsten at the focal spot, not being in contact with the copper behind it, melts right through, thus ruining the target.

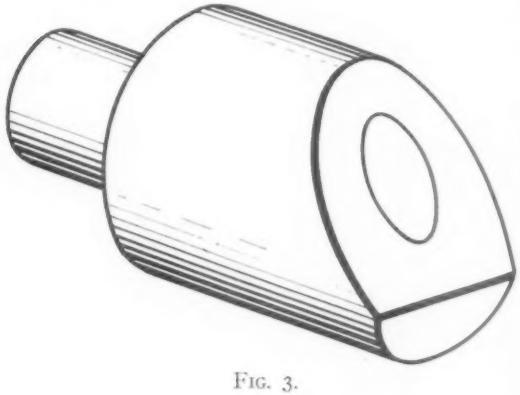

FIG. 3.

If exposures were made in rapid succession with a very fine focus tube, there would be an advantage in increasing the present size of the all-tungsten target so as to give it more heat capacity and more radiating surface. The same increase in heat capacity and radiating surface can be secured with less weight by such a construction as is shown in Fig. 3 and again, in section, in Fig. 4. In this case the target consists of a very thick tungsten cylinder pressed into a block of molybdenum. The latter metal helps in this way, that it is lighter than tungsten, which means more radiating surface for a given weight, and that it has about twice the heat capacity for a given weight.

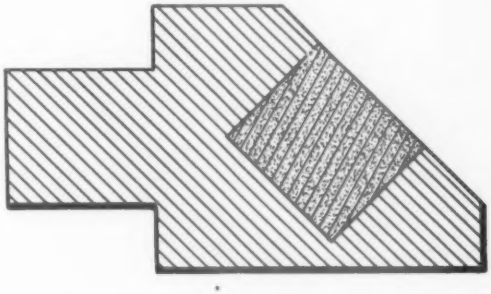

FIG. 4.

But, in the way in which the very fine focus tube now seems to be used in practice, the exposure would always start with a relatively cool target. For this and the above reasons there appears to be no advantage in increasing the heat capacity and radiating surface of the present all-tungsten target in the fine focus tube.

The above relations may be seen at a glance by an inspection of the following incomplete table. It shows current values just insufficient to cause melting, starting with the target cold and with the tube always backing up the same spark gap

(4½″). The focal spots were all of the same size.

Type of Target.	Milliamperes 3 sec.	10 sec.	30 sec.	Equilibrium
Copper-backed tungsten	38	35	30	..
Molybdenum-backed tungsten	..	35	25	15
Regular tungsten ..	30	..	15	12.5

Water Cooling of the Target.—This will help the sharp focus tube, at least to this extent, that the exposure will then always start with a cold target. It will, furthermore, make it possible for the tube to carry almost as much energy for an indefinite period as it does for a very short one. This subject has yet to be quantitatively investigated for the actual conditions met in practice.

Direct Current Excitation.—Considerable help may also come from the use of a constant potential continuous current source. Some preliminary experiments by Dr. Hull seem to indicate that, working with the proper voltages to give the same mixture of rays (having the same proportions of the different wave-lengths), the *x*-ray intensity for the same heating of the target is about one-third greater with constant potential than it is with the usual sine wave. This gain would not seem to justify the increased complications in such a generator, but careful investigation may show that the advantage is really much greater and for the following reason: When a tube is run hard on the ordinary sources of current supply, the focal spot always gets very rough and often cracks. The sharp points and edges so formed are in a very poor position to give up their heat to the heavy metal mass behind and, to this extent, the limiting energy input must suffer. The roughening action appears to be due to the forces of heat expansion and contraction brought into play by the intermittent character of the bombardment (usually 60 cycles per second) and is lacking in the case of continuous current at constant potential. This subject merits careful quantitative investigation.

Rotation of the Target.—As an entirely different method of increasing the allowable energy input for a given size of focal spot, we are trying Prof. Elihu Thomson's scheme of rotating the target. This rotation leaves the size, and position in space, of the focal spot unchanged, but results in spreading the energy over a much larger area. We have already had such tubes in operation with the target running at 750 r.p.m., and with the focal spot describing a circle ¾″ in diameter. One of them is shown in Fig. 5. The target in this instance was rotated by means of an externally placed permanent horse-shoe magnet acting on the soft iron armature within.

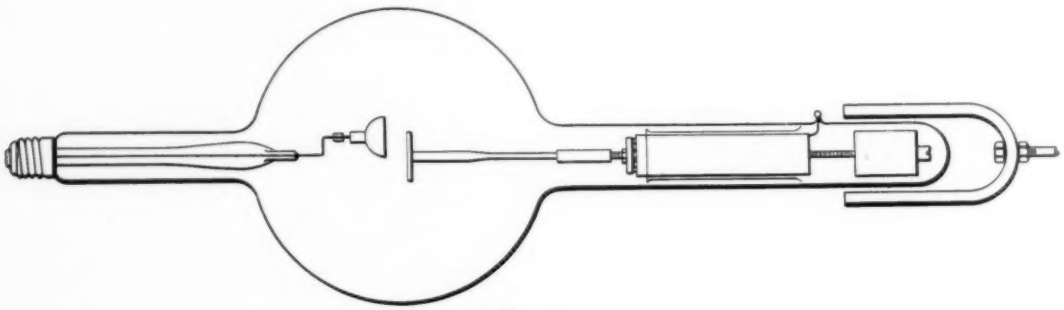

FIG. 5.

The crude experiments which we have already made seem to indicate that, with the above mentioned speed of 750 r.p.m., and with the focal spot describing a circle

¾" in diameter, we can carry two or three times as much energy for the size of focal spot used, as we can with the target stationary.

It seems as though, to justify the complications inherent in the use of a rotating target, we need something more like a 10-fold increase over the stationary target. If bearing troubles can be eliminated, this should be attainable, and more work is to be done along this line.

A Hooded Target.

For best definition in radiographic work, the rays should all come from the focal spot. With the type of hot-cathode tube now on the market, there is a very considerable emanation of *x*-rays from all over the target. By means of the ionization method, we have investigated this quantitatively, and have found that the integrated value of the rays from ½ of the target surface exclusive of the focal spot (this is of course all that counts, as those coming from the side which is turned away from the plate do not affect it) is about $\frac{1}{6}$ of the intensity from the focal spot.

All of our experimental evidence at present points to the fact that these distributing *x*-rays from the body of the target are caused by secondary cathode rays coming from the focal spot and prevented from going to the glass as they do in the ordinary gas-filled tube, by a negative electrification of the bulb.

To reduce the intensity of this disturbing factor, a cylindrical cap or hood of molybdenum has been attached to the front of the target (see Fig. 2). The cathode rays enter this hood through a small hole in the front, and the *x*-rays emerge through a second hole in the side.

The hood offers the following advantages: (a) It reduces the radiation from the surface of the target exclusive of the focal spot to about $\frac{1}{6}$ (in the present design) of what it is without the hood. Its effect in this direction is well shown by the following experiment: A lead plate with several small holes was placed about 2¾ inches above a photographic plate and 20 inches away from the focal spot (see Fig. 6). To have the effect as pronounced as possible, no cone or other diaphragm was used. Two equally timed exposures were made on the same plate, one with a hooded tube and the other with an unhooded one having the same sized focal spot. The same

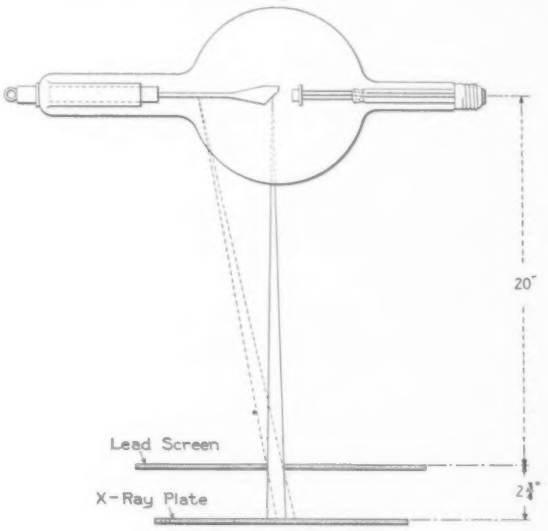

Fig. 6.

voltage and milliamperage were used in both cases (see Fig. 7). The black, sharply defined circles were produced by the rays coming from the focal spot, while the balance of the picture is due to the rays coming from the surface of the target other than the focal spot. The fact that the same intensity of rays was emitted from the focal spot in both tubes was confirmed by the equal density of the circular areas in the two pictures. It is clear that the halos in the right-hand picture, made with the hooded target, are much less intense than they are in the other one.

The fact that the intensity of radiation from the back of the target has been in this way reduced to $\frac{1}{6}$ of its value, might well

lead the roentgenologist to hope for much better definition in radiograms of human beings, from the use of the hood. Experience teaches, however, that the gain is very slight. It can be seen by the direct comparison of two plates, but could with difficulty be confirmed without making the direct comparison. The reason for this doubtless lies in the fact that in those cases where one could possibly hope to see it, namely, with thick objects such as the head, it is almost masked by the much more disturbing effect of the secondary rays coming from the object itself. In those cases where this effect is reduced, as by the use of the Bucky diaphragm or the Cole double-slot method, the gain should be much more apparent.

(b) The hood reduces the danger to the operator as it, together with the cathode, cuts off all but the narrow cone of direct rays which is actually desired.

(c) It greatly reduces the amount of inverse current which can pass through the tube when the latter is run on alternating current and with sufficient energy to heat the focal spot to temperatures approximating that of the cathode spiral or higher. As a result such a target makes it possible to use the tube for heavy radiographic work on an induction coil in cases where, without the hood, the inverse current would be so great as to cause destructive local heating at the cathode end.

(d) It reduces the blackening of the bulb which results if a tube is run so hard that the focal spot is melted and volatilized.

(e) It reduces the danger from putting excessive currents through the tube, for a melted globule of tungsten, which might otherwise strike the glass bulb and crack it, is now very likely to be intercepted by the hood.

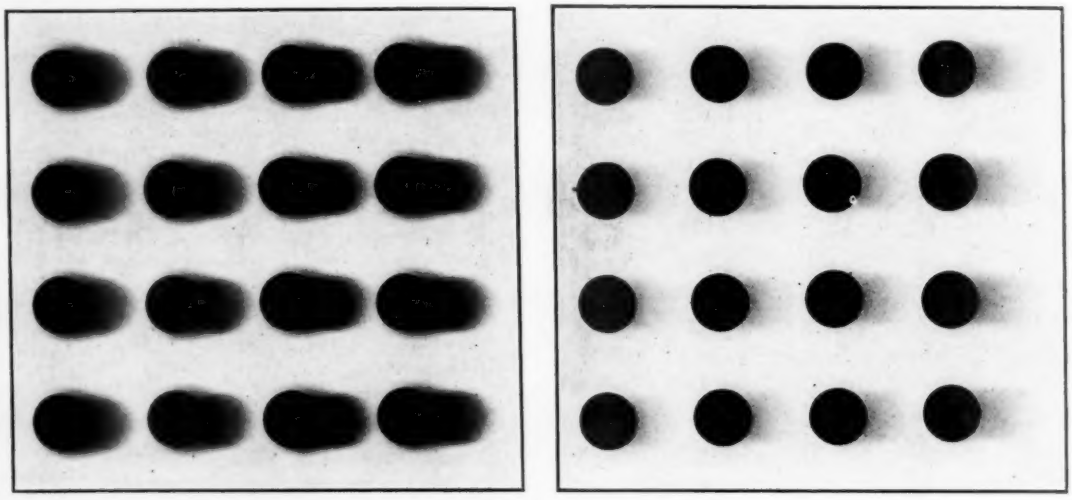

Fig. 7.

For certain purposes, the hood promises to be very useful. In the light of experiments, to be described later, however, on the use of much smaller bulbs and on the use of water-cooled targets, it may not have as much importance as would otherwise attach to it.

Size of Bulb.

This can be very greatly reduced, probably to 4 inches for most work.

The chief advantages to be derived from the adoption of a smaller bulb are the following:

(1) For the same amount of x-ray pro-

tection, it permits of a great reduction in the size and weight of the tube holder.

(2) It permits a closer approach of the diaphragms to the focal spot and hence gives better definition.

(3) It permits a closer approach of the focal spot to the object to be rayed. This is in some cases desirable.

(4) It decreases the danger of tube-breakage in handling.

Tipless Bulb.

We find that the seal-off tip can be removed from the bulb to the end of one of the side arms, so that it is later covered by the terminal cap. This seems to considerably simplify the design of a satisfactory tube holder, and it also reduces the danger of tube breakage.

Fig. 8.

situation, however, it developed that with the very thick aluminum filters which it seemed desirable to use, the problem of protecting the patient, with the cross-fire technique and many ports of entry, was more difficult than anything which had been met before. It could of course be taken care of by the development of a suitable tube holder. The problem is greatly simplified by the use of a hooded target with a piece of tungsten foil or other filtering material covering the opening in the hood (see Fig. 8). With this arrangement, no direct unfiltered rays can leave the tube.

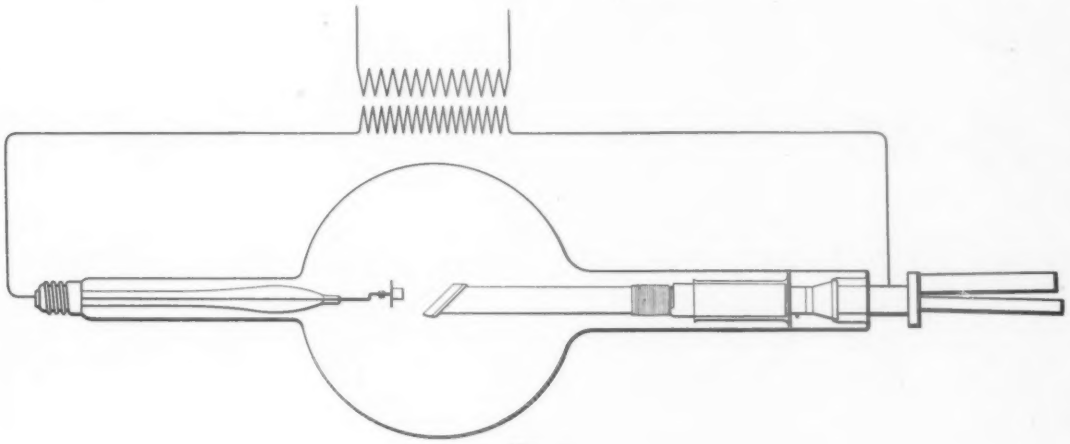

Fig. 9.

High Potential Tube With Hooded Target and Internal Filter.

At the Cleveland meeting of the Society last year, I reported on some experimental work on tubes which could be operated backing up a 15 or even a 20 inch spark. It seemed at the time that it might be interesting to have such high potentials tried out for therapeutic work. Upon studying the

High Power Tube With Water-Cooled Target.

The experimental development of this tube has had, so far, for its objective, continuous service at very high power, for industrial applications. But it is already clear that there are certain advantages connected with this tube which must be taken very seriously by the roentgenologist. The most

striking differences between it and the present hot-cathode tube are the following: Owing to the effective cooling of the target, very large amounts of energy can be carried, without heating the focal spot to the point where inverse current can pass. The tube is therefore capable of rectifying its own current even for heavy loads. The cooling of the target also prevents the strong heating of the glass, due to radiation from the target, which takes place in the present tube on continuous operation.

Description.—The general design may be seen in Fig. 9. The cathode is the same as has been used in the regular Coolidge tube. The target consists of a copper-backed piece of tungsten which is silver-soldered to the end of a thin-walled copper tube. Inside this copper tube is another smaller one through which water is brought to the back of the target, from which point it escapes through the space between the two tubes.

As shown in the diagram, the tube is connected directly to the terminals of a high-tension transformer, without any auxiliary rectifying device.

Performance.—A good idea of the exceedingly regular operation of the water-cooled tube is given by the performance of tube X-179, which was run continuously for 42 hours, carrying a current of 100 milliamperes and supporting a potential of 70,000 volts (peak value). During the whole test, the filament current necessary to make the tube draw 100 milliamperes varied only from 4.58 amperes to 4.50 amperes. These values represent the extreme change observed during 42 hours. It was, furthermore, a perfectly regular progressive change, taking place in the direction of a lowering of the filament current with the time of operation. The change was not only small, but was clearly due not to any change in vacuum but to a gradual pulling out of the cathode spiral, which can be entirely obviated by a suitable cathode design. At the end of the test, the target had sprung a-leak. In the next design of target the water was brought closer to the face. This one ran 68 hours continuously at 100 milliamperes and 70,000 volts, and then failed just as the first one had. A later target design appears to eliminate the trouble experienced in the above mentioned models.

Capacity.—Our life-tests, as stated above, have been run at 100 milliamperes and 70,000 volts. But the same tubes have been run continuously at 200 milliamperes and 70,000 volts and at 100 milliamperes and 100,000 volts. There is no apparent reason why, by increasing the size of target and focal spot,

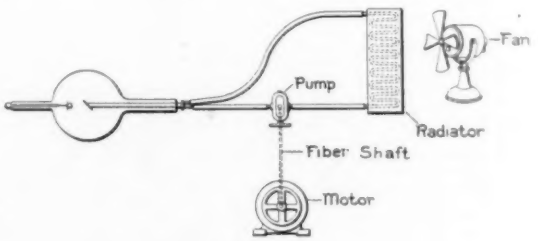

FIG. 10.

the allowable energy input should not be raised to at least 25 or 50 kilowatts for continuous operation.

Different Water Cooling Systems.—Over 99 per cent. of the energy supplied to such a tube is delivered to the water used in cooling the anode. A simple calculation shows that an energy input of 200 milliamperes at 70,000 volts is sufficient to raise the temperature of a liter of water from 20° centigrade to the boiling point in 33 seconds. This shows that, for continuous operation at this high power, it is necessary, if boiling is to be prevented, to pass through the target at least 2 liters of cold water per minute. There are two easy ways of doing this. The first consists in connecting the tube right to the faucet and using tap water. To do this necessitates grounding one side of the *x*-ray transformer. This appears to be unobjectionable for work calling for voltages not to exceed, say, 70,000, and this system when applied to the above combination appears to

make the simplest conceivable high power *x*-ray outfit. It seems admirably adapted to the industrial applications at least, such as sterilization, insecticide, metal radiography, and the coloring of glass, porcelain, etc.

The second method of handling the cooling problem involves the use of a radiator (the automobile types are admirably suited to the purpose), a water-circulating pump, and a fan (see Fig. 10). With this method the whole water system is insulated, and the middle point of the transformer secondary is grounded. As a result, corona troubles are reduced, and in so far as this effect is concerned, it becomes possible to go to

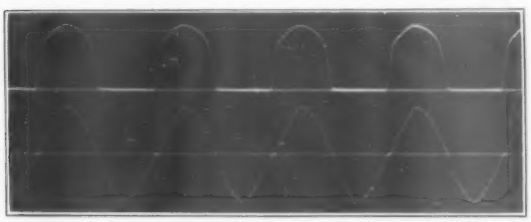

FIG. 11. 25 k.w. G. E. transformer. Tube load: 100 M.A., 70 Kv. Upper curve: tube current. Lower curve: useful voltage above zero line and inverse voltage below.

twice the voltage that could be used with the other system. It is therefore the method which recommends itself for therapeutic work. The ordinary Ford radiator with a 12″ desk fan and a small water pump takes care of at least 7 kw. continuously. By using a more powerful fan or a cellular (instead of a tubular) radiator, the effectiveness of this cooling system could readily be doubled.

A small desk fan or Sirocco blower is also necessary for cooling the bulb.

Suitable Source of Current Supply.—The water-cooled tube, when rectifying its own current, places new demands on a transformer. Only one half-wave passes through the tube, with the result that, unless the transformer is suited to the work, the voltage on this half-wave may be much lower than on the other half. This would introduce a new difficulty in the measurement of voltage. A spark-gap, for example, when used in the ordinary way, would measure the inverse voltage and not that corresponding to the *x*-rays produced. Furthermore, if the inverse voltage was much higher than that in the right direction, there would be a needless strain on the insulation of the transformer, and increased corona from the wires leading to the tube.

FIG. 12. 25 k.w. G. E. transformer. Tube load: 200 M.A., 70 Kv. Upper curve: tube current. Lower curve: useful voltage above zero line and inverse voltage below.

The oscillograms, Figs. 11 and 12, show the behavior of the tube under heavy load on a suitable transformer. The upper curves show that the tube completely rectifies its own current, as there is nothing below the zero line. The lower curves, indicating voltage, were obtained by the use of a very sensitive vibrator in series with a high resistance water column which was connected in parallel with the tube.

The potential curves show but little departure from a sine wave. The application of a millimeter scale to the curves shows that in the case of the 100 milliampere load the peak value of the inverse voltage is only 2.5% greater than that of the direct voltage,

FIG. 13. W. & B. transformer. Tube load: 100 M.A., 41 Kv. Useful voltage above zero line and inverse voltage below.

and that even in the case of the 200 milliampere load, it is only 4% greater.

Fig. 13 shows the voltage curve obtained with the same tube excited from one of the regular *x*-ray transformers now on the market. (It happened to be a Waite & Bartlett. The mechanical rectifier was not used.) Inspection of the curve shows that the inverse voltage is much higher than the direct voltage. Measurement of the peak values made on the oscillogram shows them to be in the ratio of 31.5 to 14.8; or, in other words, the inverse voltage is 113 per cent. higher than the direct or useful voltage.

It is obvious from the above that the high power water-cooled tube can be used with perfect satisfaction on a large transformer of suitable design, with no auxiliary rectifying device. It is equally clear that it must not be used as a self-rectifying tube on such transformers as those now on the market, which were designed with a view to utilizing both half-waves.

In these experiments, furthermore, the resistance of the mains supplying the transformers was kept very low and the voltage was controlled through the field excitation of the alternator. Even with a suitable transformer, the scheme does not lend itself to resistance control, for the effect of resistance in series with the primary is to lower the useful secondary voltage but not the inverse. In practice the simplest method for controlling voltage would be by means of an auto-transformer or by the use of a number of taps on the primary.

The above considerations will apply with equal force to the use of a kenotron for the rectification of current for the ordinary Coolidge tube. The combination, to be satisfactory for work where heavy tube currents are ever to be employed, necessitates the use of a relatively large transformer, that is unless some special method is employed for the reduction of inverse voltage.

Advantages of Water Cooled Tube Excited Directly From Transformer Without Auxiliary Rectifying Device.

They may be summarized as follows:

(1) High power for continuous operation—there is no power limit in sight.

(2) Noiseless operation.

(3) Simplicity and reliability.

(4) This system will make it possible to go without difficulty to voltages much higher than 100,000.

(5) It is perfectly adapted to the operation of any desired number of tubes running in parallel.

(6) Owing to the high power which can be employed and to the fact that the target is cooled, the system is well adapted to the production of homogeneous rays. The target facing can be made of any one of a large number of the metals and the rays can then be passed through a filter of the same material.

(7) The water-cooled target permits of the use of a much smaller bulb than would otherwise be necessary for the same power.

(8) The close voltage regulation which is necessary for the satisfactory operation of the above system is also helpful in the exact duplication of results, for a considerable degree of inaccuracy in the adjustment of filament temperature has no appreciable effect on voltage and hence on penetration.

The Use of a Kenotron for Rectifying Current With the Present Coolidge Tube.

Provided a suitable transformer is used, a kenotron* may be substituted for the mechanical rectifier, for the operation of the ordinary Coolidge tube.

As has been pointed out in the preceding section, the transformer requirements are, for this purpose, exactly the same as for the self-rectifying water-cooled tube.

There is much to be said in favor of the

* Saul Duschmann, Gen. Elect. Rev., 1915.

use of the kenotron, and the advantages (2), (3), (4) and (8) which have been cited for the water-cooled tube operated directly from a transformer, apply equally here.

The Control of Filament Temperature.

To simplify and render more accurate the technique of the Coolidge tube, some source of filament current supply which is much better than the storage battery or the simple transformer is needed. The desideratum is a source of perfectly constant potential. This would allow the filament temperature to be controlled by means of a dial switch, each point of which, with the same tube, would always mean the same temperature, and hence the same milliamperage.

After working with magnetos, boosters, Nernst iron wire ballasts, etc., we have finally found what appears to be a perfectly satisfactory solution of the problem. It consists in the use of a specially designed transformer in conjunction with the usual filament current transformer. It is the function of the former to make it possible to deliver to the filament constant current, even though the line voltage may fluctuate greatly and suddenly. The regular filament current transformer is retained merely to provide the necessary insulation between the filament circuit and the supply mains. This combination draws its energy directly from the mains in the case of alternating current installations, and from the alternating current side of the rotary in the case of direct current installations. For induction coils run from direct current, where there is no alternating current supply, it will be necessary to add to the above combination a small rotary.

The special constant potential transformer referred to above, has no moving parts and no time lag. The present model allows the filament current to fluctuate less than one per cent. when the supply voltage varies 25 per cent. This means that it completely takes care of the ordinary fluctuations in the supply voltage, due to causes external to the *x*-ray installations and of the sudden drop caused by the closing of the *x*-ray switch as well.

Change in filament temperature may be effected by means of a dial switch which controls a resistance connected in series with the primary of the ordinary filament current transformer.

The above method does away with the need of any accurate adjustment of either a resistance or an impedance and with the need of the accurate reading of an ammeter or milliammeter. Each point on the dial means always the same filament temperature and the same milliamperage.

It will mean a great simplification in the use of the tube. In those cases, for example, where it is used for radiographic work exclusively and where the operator prefers to use the same penetration and the same milliamperage for everything, he will never need to think of anything but his main switch and his watch. It will also be a great convenience in those cases where the technique of the operator combines in the same case fluoroscopy and radiography. For the filament temperature will be carried from that requisite for fluoroscopy to that required for radiography by moving the dial switch from one button to another, and these two buttons can be adjacent to one another.

Accurate Measurement of Tube Voltage.

The best method by far would appear to be the one which is generally used by the electrical engineer in high potential work. It consists in the use of a voltmeter and a special potential coil properly located in the transformer. If there is sufficient iron and copper in the transformer, this method is very simple and should be exceedingly satis-

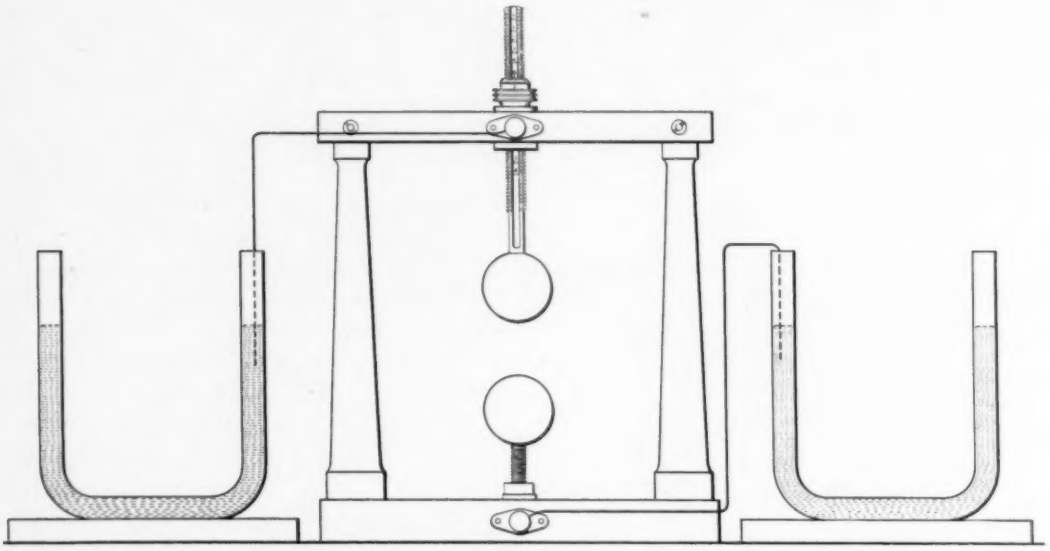

FIG. 14.

factory. If, on the other hand, a small transformer is made to do heavy work, there will be a large correction to be applied to the voltmeter reading and this correction will be a variable quantity dependent on the load. This last applies, and with greater force, to the use of a voltmeter across the primary. In either of the two latter cases, however, there should be no trouble in making an accurate voltage calibration, for the different loads actually employed, by means of a sphere gap.

This instrument (see Fig. 14) has been standardized by the American Institute of Electrical Engineers. A table of spark lengths, and the precautions necessary in using the instrument and the corrections to be applied, are given in their Standardization Rules (Edition of July 1, 1915). For the voltages now used in *x*-ray work, the 62.5 mm. spheres will be found most satisfactory. The distance between them is adjustable by means of the milled nut at the top, as shown in the diagram, and can be read on the micrometer head connected with it. The glass U-tubes on either side of the gap are filled with distilled water. Their purpose is to interpose sufficient resistance in the circuit to prevent destructive arcing on the surface of the spheres. The tubes may well be about ¾ inches internal diameter and of such length that there shall be in each of them about 15 inches of water column.

In *x*-ray work, the usefulness of the sphere gap will doubtless be confined exclusively to calibrating the combination of voltmeter and transformer.

Research Laboratory of the General Electric Co., Schenectady.

ROENTGEN RAY SPECTRA

By ALBERT W. HULL

THE following is a preliminary report of measurements of roentgen ray spectra. It is presented as a first contribution to exact roentgenology and an example of what can be done in the way of accurate measurement of the quality and intensity of roentgen rays produced by a standard tube.

Our ability to make these exact measurements of roentgen ray quality is due to five great discoveries of the last three years.

The first, by Professor Laue and his colleagues, is the proof that roentgen rays are the same in nature as ordinary light; that is, electric waves of definite wave-length. In light, the quality,—that is, color, absorbability, actinic and chemical effect—depends only upon wave-length, and recent experiments have shown the same to be true of roentgen rays. This gives us a standard of quality—the wave-length.

The second great discovery is a tube that behaves the same yesterday, to-day and forever, and every tube exactly like every other one—by Dr. Coolidge.

Third, the discovery of a source of constant high voltage of unlimited power, by means of the kenotron—by Dr. Langmuir and his associates. These last two, the standard tube and standard power to run it, give us something definite to measure.

Fourth, a roentgen ray spectrometer which enables us to break up a beam of roentgen rays into its constituent wave-lengths, in the same way as a beam of light is broken up into its constituent colors by a prism—by Professor Bragg and his son.

Fifth, the proof by Professor Barkla, of London, and his associates, that a reliable measure of the intensity of a beam of roentgen rays is the ionization it produces in a chamber large enough to completely absorb it.

These last two, the spectrometer and ionization chamber, give us the means of resolving the roentgen ray beam into its constituent wave-lengths and measuring the intensity of each wave-length.

Regarding the first and last of these discoveries, namely, the proof that roentgen rays are identical with light except in wave-lengths, and that a large ionization chamber can measure intensity, I need only say that the evidence is so good that it is accepted by all roentgen ray physicists.

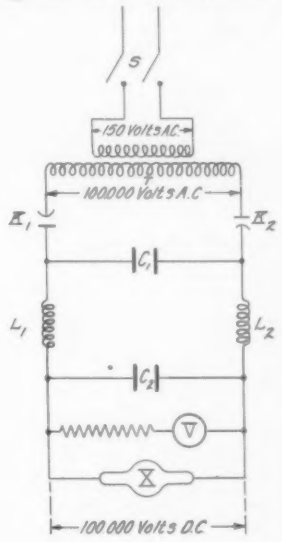

FIG. 1.

The reproducibility of the hot cathode tube can be verified directly by any roentgenologist, but it is worth mentioning that any lack of reproducibility is a theoretical impossibility in a well exhausted hot cathode tube. At the same voltage and current it *must* give the same rays, both in quality and quantity, at all times.

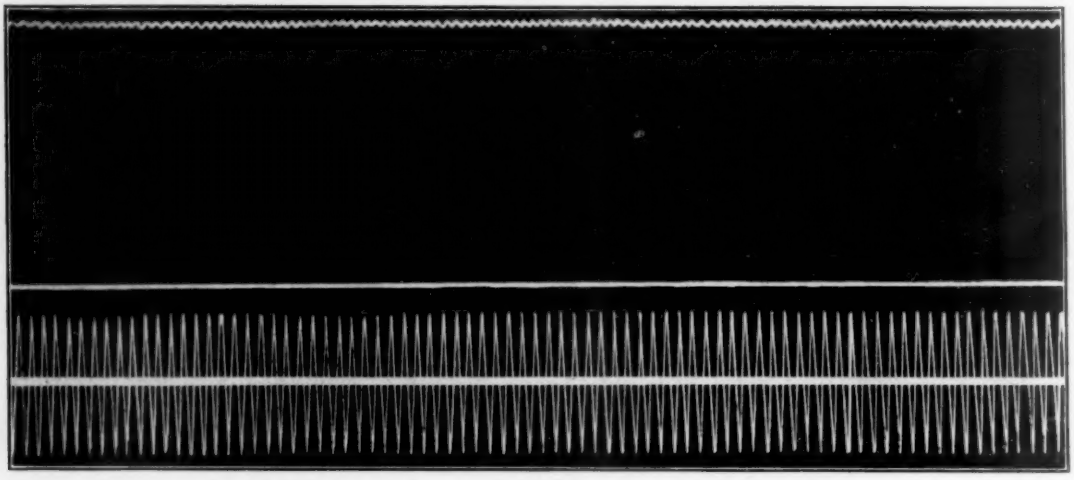

FIG. 2. 92,000 volts, 55 milliamperes. Lower curve primary A. C. wave, upper curve D. C. voltage.

The other two "implements," the high voltage apparatus and the spectrometer, will be described in detail.

THE HIGH VOLTAGE APPARATUS

The arrangement of apparatus for obtaining high constant voltage with large power is shown in Fig. 1.

Alternating current of 2,000 cycles and 150 volts flows through the operating switch S to transformer T, which boosts the voltage to 100,000 volts. This 100,000 volt current flows through the kenotrons K_1 and K_2, which rectify it, through the choking coils L_1 and L_2, to the roentgen ray tube X. The small condensers C_1 and C_2 (capacity 1/1000 microfarad each), together with the choking coils L_1 and L_2 (inductance about 200 henries each) smooth out the voltage oscillations that remain after rectifying, so that the voltage at the terminals of the roentgen ray tube is constant within less than 1% (for 5 kw. or less) and this constant voltage is measured by an ordinary voltmeter V of very high resistance.

The constancy of the voltage is shown in the oscillograms * of Figs. 2 and 3, which were taken with a water resistance in parallel with the tube. The lower curve in each is the 2,000 cycle primary voltage, the upper curve the voltage at the terminals of

* It was found necessary to retouch these oscillograms in order to get plates for publication, which destroys much of their value.

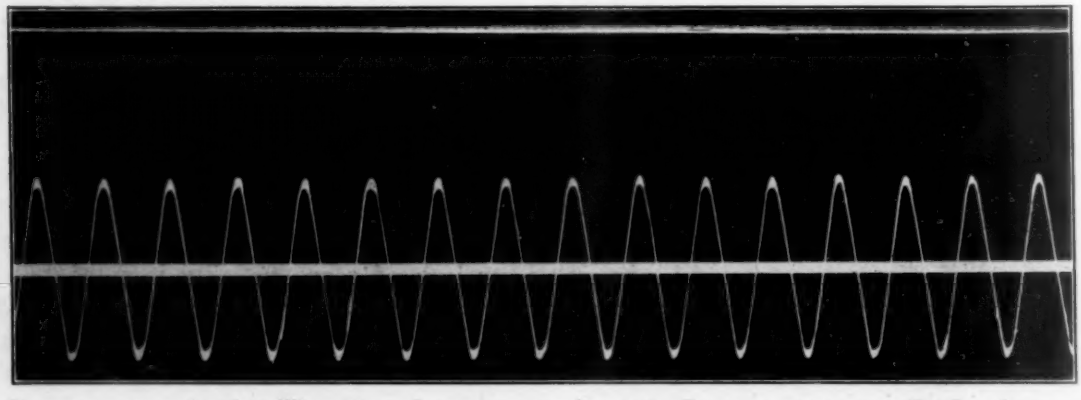

FIG. 3. 50,000 volts, 65 milliamperes. Lower curve primary A. C. wave, upper curve D. C. voltage.

the tube. In Fig. 2 the voltage is 92,000 and the current 55 milliamperes, making a load of 5 kw. Under these conditions it can be seen that the voltage fluctuates about 1%. The fluctuations are much smaller for lighter loads, and can be still further reduced at voltages below 50,000 by connecting the two kenotrons in parallel and using the middle point of the transformer.

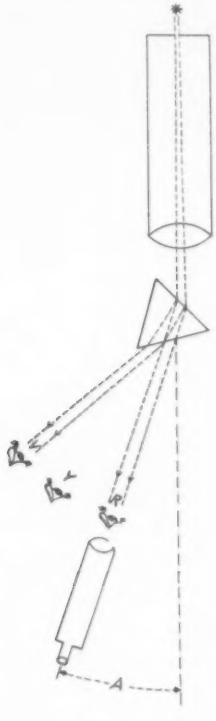

Fig. 4 (*a*)

Fig. 3 shows the result. Here the voltage is 50,000 and the current 65 milliamperes, making 3.2 kw. The base line for the constant voltage has been made coincident with that of the primary 2,000 cycle wave. The fluctuations probably do not show in the reproduction. They are about 1/10 of 1%.

These tests prove that we have a source of voltage sufficiently constant for our purpose. In fact, it is as constant as that of any low voltage direct current generator, and is read with the same precision on the same kind of voltmeter.

The Roentgen Ray Spectrometer

The principle of the spectrometer can best be understood by comparison with the ordinary light spectrometer. If one wishes to analyze a beam of visible light into its constituent colors, he lets it fall on a prism, as in Fig. 4(a). By placing the eye at *R*, *Y* or *V* he will then see red, yellow, or green, respectively, provided these colors are present in the beam, and he can estimate by the eye the relative intensity of the different colors. Thus, if the beam of light came from an incandescent carbon filament the yellow would be most intense; if from a mercury arc the green would predominate.

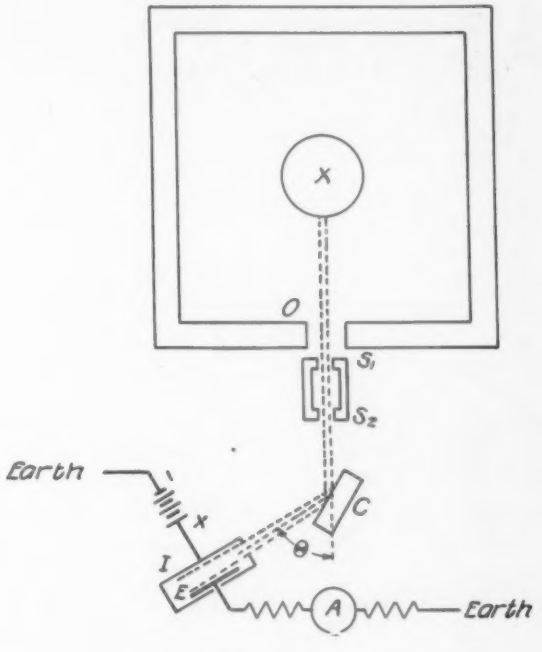

Fig. 4 (*b*)

For accurate work, such as is done in our lamp factories, the eye is not a sufficiently reliable judge either of color or intensity. It is therefore replaced by a telescope. The color of each constituent of the light is re-

corded in terms of its wave-length, which can be calculated from the angle A of the telescope, and the intensity is measured by a photometer.

A record is thus obtained of the intensity of each wave-length (that is, each color, wave-length being a more precise definition of color) in the beam of light. The results are generally shown graphically, by plotting the wave-lengths as abscissas (horizontal) and the intensities as ordinates (vertically). Fig. 5 shows the spectrum, as it is called, of a tungsten Mazda lamp measured and plotted in this way. The shaded portion is the

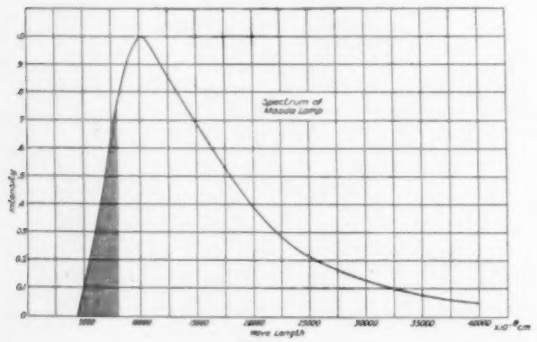

FIG. 5.

visible part, that to the right being the so-called infra red; that is, wave lengths too long to affect the eye.

The roentgen ray spectrometer operates on exactly the same principle. Since the wave-lengths are much shorter than those of visible light, the glass prism has to be replaced by a crystal of rock salt or iceland spar, and the photometer by something that is sensitive to short wave-lengths, such as a photographic plate or an ionization chamber. We use the latter because it is the more accurate.

The spectrometer is shown in Fig. 4(b). The roentgen ray tube is completely enclosed in a lead box ½ inch thick. The rays emerge from the box through the small hole *O*, pass through narrow slits *S*, and S_2, and fall on the crystal *C*. This crystal reflects each wave-length in a different direction. The reflected rays enter the ionization chamber I, where they make the gas electrically conducting and cause a current to flow from the outside of the chamber, which is highly charged, to the central electrode E, and thence through the sensitive ammeter A to earth. This current is proportional to the intensity of the rays entering the chamber. The angle θ at which the chamber is set tells which wave-length is entering the chamber. Thus, by moving the chamber around gradually from small to large angles, and recording the current for each angle, we have a record of the intensity of each wave-length in the spectrum which we are examining.

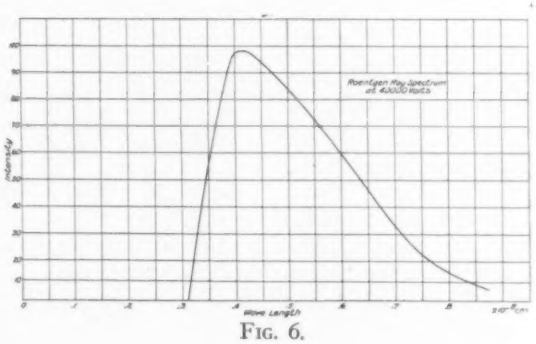

FIG. 6.

The Roentgen Ray Spectra.—Fig. 6 shows the spectrum thus obtained of a tungsten target at 40,000 volts and 1 milliampere, plotted in the same way as that of the hot tungsten filament, Fig. 5. The scale of wave-length, which is laid off horizontally, is measured in the same units as for the visible spectrum, the so-called Aengstrom unit, which is a hundred-millionth of a centimeter. Thus the wave-lengths given by a roentgen ray tube can be compared directly with those of an incandescent lamp. The intensity of each wave-length is equal to the vertical distance from the corresponding point on the horizontal axis up to the curve. For example, the intensity of the rays of length .3 is zero; that is, no rays of this length are produced by the tube at

40,000 volts. The rays of length .35 have an intensity 55, those of length .42 have the greatest intensity of all, namely, 97. The units in which intensity is measured are chosen arbitrarily, since only *relative* intensity is desired here. They will later be referred to some standard.

Fig. 7 shows the spectra obtained at five different voltages, from 20,000 to 40,000. Two things are very striking. As voltage increases, the average wave-length decreases very rapidly, which means increased penetrating power, a fact already well known.

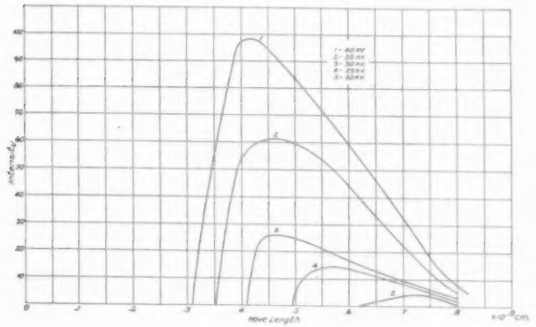

FIG. 7.

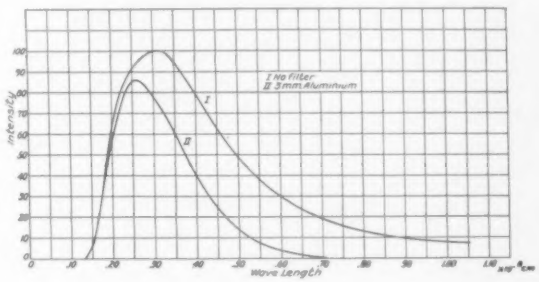

FIG. 8.

And at the higher voltages the intensity is greater for *all wave-lengths.*

Thus an increase of voltage increases not only the penetrating radiation but the soft radiation also, and it is only by the use of some selective filter, such as aluminium, which absorbs the long wave-lengths more than the short ones, that one can hope to obtain penetrating radiation without soft radition. Even so, the amount of aluminium necessary is very large, much larger than has commonly been supposed. Fig. 8 shows the spectrum at 70,000 volts, first without any filter (curve 1) and then with 3 mm. of aluminium (curve 2). It can be seen that the aluminium has reduced the intensity of the soft radiation (long wave-lengths) much more than that of the penetrating, but there is still an enormous amount of soft radiation left. This could, of course, be much further reduced by the use of still more aluminium, but not without cutting down the intensity of the useful penetrating rays to a small fraction of its original value. With the new powerful water-cooled tube described elsewhere in this issue it will be possible to use this method and still have left sufficient intensity for practical work. This will open up a new field in deep therapy and roentgenography. In addition, it is hoped by the use of particular target materials which give a very powerful characteristic radiation for some particular wave-length, to obtain still purer "monochromatic" rays of high penetration. Experiments in this line will be reported in the near future.

Comparison of Alternating and Direct Voltage Spectra

The work described above was all done with constant potential. It is important to know whether the same results can be obtained with an alternating potential (rectified, either by the tube itself or by some reliable rectifier), and whether the spectra obtained by the two methods (constant and fluctuating potential respectively) are sufficiently alike so that work done with one can be compared with work done with the other. In answering "Yes" to this question, I want to be very careful to be clearly understood. There are a great many kinds

Curve 1. Oscillogram of induction coil voltage.

Curve 2. Voltage wave of standard transformer.

FIG. 9.

of alternating potential, which are very different from each other. Fig. 9 shows two typical voltage curves. Curve 1 is the voltage given by an induction coil with mercury interrupter; Curve 2 that of a standard 25 kw. transformer.

It is probable that the spectra given by these two machines at the same maximum voltage and same current would not be the same, or even approximately so. I think, though as yet I have tried it only for the sine wave and constant potential, that I could find *a voltage* and *a current* for the one, at which it would give a spectrum nearly the same as that given by the other at a *different (definite) voltage and current.* For example, the one machine might require 70,000 maximum volts and 2 milliamperes to give the same spectrum as the other machine at 60,000 volts and 1 milliampere. Knowing this conversion factor, it would be possible to reproduce with machine (2) work done on machine (1).

But I wish to emphasize that the conversion factor is likely to be *big,* for machines differing greatly in wave form, and can by no means be neglected. In order to use the conversion factor it is of course necessary to be able to measure the true maximum voltage, a question fully discussed by Dr. Coolidge elsewhere in this issue.

The simplest form of alternating potential, and at the same time the most reproducible and most easily measured, is the simple sine wave (curve 2, Fig. 9). This is the kind of voltage wave that is always obtained from a good transformer when not overloaded. If, in addition, we use as rectifier a kenotron, which simply suppresses the lower half of the wave without changing the upper (useful) half, or, in case of the hot cathode tube, we make the tube act as its own rectifier, then we have a fluctuating potential of definite form for which the "conversion factor" can be obtained. This has been done for the voltage of 70,000, and Fig. 10 shows the results. The voltage factor is unity; that is, the maximum A. C. voltage is the same as the D. C. voltage.* The current factor is $\frac{3}{2}$; that is, 3 milliamperes A. C. at 70,000 volts maximum are required to give the same spectrum as 2 milliamperes D. C. at 70,000 volts. Further data regarding the factor of conversion from sine wave to constant potential will be published soon, in connection with the constant potential spectra.

In conclusion I wish to emphasize the fact that it is the *wave-length* of the rays used, and not voltage or spark gap, that determines penetration, therapeutic action,

* The *exact* equality of the voltages cannot be affirmed without further experiment, as the transformer used was not fitted with a special voltage coil. The difference, if any, is certainly very small.

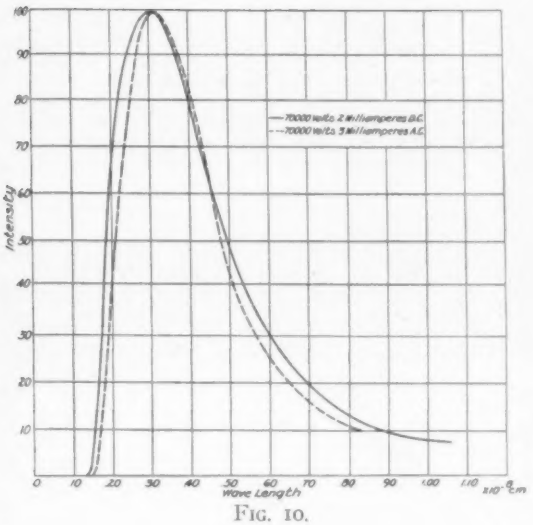

FIG. 10.

and all other effects. In order to duplicate work it is necessary to use a beam containing *the same wave-lengths in the same relative intensity*, that is, the same *spectrum*. With constant potential, or fluctuating potential of definite wave-form, it is probable that the unfiltered spectrum depends only upon voltage. If this proves to be so, the only measurements which an operator will have to make under these conditions are voltage, thickness of filter, and milliampere-minutes. This question is being carefully investigated, and will be reported on in the near future. The one thing that can be stated with absolute certainty at present, and which is of fundamental importance, is *that if one works always with rays having the same spectrum, the only variable is milliampere-minutes.*

It will probably never be possible to compare completely by any simple numerical ratio, the effects of roentgen ray beams that have different spectra. For they differ not in magnitude but in kind. It is therefore desirable to devise means for obtaining always the same spectrum, or one of two or three standard spectras, and doing all work under one of these standard conditions. It is to be hoped that the recently appointed committee on standardization will take up at an early date the problem of standardizing roentgen technique, so that all work done by members of this Society will be done with one of two, or at most three, spectra—*spectra*, not voltages.

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General Electric Company
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FACTORS GOVERNING PHOTOGRAPHIC ACTION OF ROENTGEN RAYS

By J. S. SHEARER, Cornell University

BEFORE the development of modern appliances for control and measurement of current and voltage and when all information was derived from the ordinary tube a great variety of opinions were expressed as to the factors controlling roentgen radiation. Having at disposal a means of readily comparing high voltages and with the Coolidge tube it seemed advisable to study this matter further. The present paper deals with the action when the only absorbing material is the envelope. Another series will be made with different thickness of absorbing material when time permits.

There are good theoretical reasons[1] for believing that with a given target and wave-form the roentgen radiation depends on:

1. The tube current,
2. The *square* of the effective voltage at the terminals of the tube,
3. The time.

Also as the radiation spreads from the source the amount *received* on a given area decreases as the square of the distance.

As there is no easy way in which to infer actual exposure from the darkness of a plate, the photographic method of measurement does not generally appeal to one. But if we secure a series of *equal densities* on the *same plate* so that speed of emulsion and differences of development are eliminated there can be no doubt that the plate becomes a very accurate means of determining equality of radiant action on the emulsion.

The formulation of the above laws of radiation give the expression:

$$\text{Roentgen Radiation} = \frac{K \times \text{Current} \times \text{Voltage} \times \text{Voltage} \times \text{Time}}{\text{Distance} \times \text{Distance}}$$

Thus if 20 M. A., 35 K. V., 25″, .5 sec. gives a certain density, in order to get the same density with 30 M. A., 40 K. V. 30″ we compute the time as follows:

$$\underset{\text{First Case}}{K\frac{20 \times 35 \times 35 \times .5}{25 \times 25}} = \underset{\text{Second Case}}{K\frac{30 \times 40 \times 40 \times t}{30 \times 30}}$$

Or to the nearest tenth this gives .4 sec.

The following test plates show how well this works out in practice. Any deviations can be traced to slight errors in setting the voltage or to the small fluctuations in filament current.

Plate 1. Voltage constants, 35 K. V
Current constant, 10 M. A.

Target plate-distances	10	20	30	40	50	in.
Exposure times	.1	.4	.9	1.6	2.5	sc.
Spot numbers	1	2	3	4	5	

Plate 2. Voltage constant, 35 K. V.
Distance constant, 25 inches

Currents	10	20	33	50	100	M. A.
Times	1	.5	.3	.2	.1	sec.
Spot number	1	2	3	4	5	

[1] Beatty (*Le Radium*, Jan., 1914, pp. 9-15) gives the relation

$$\frac{\text{Roentgen Energy}}{\text{Cathode Ray Energy}} = \frac{2.54\ A\beta^2}{10000}$$

where A is the atomic weight of the arget material, β = speed of exciting electrons divided by the velocity of light. But β^2 is proportional to voltage consumed by the tube, hence

$$\frac{\text{Roentgen Radiation}}{\text{Tube Current} \times \text{Tube Voltage}} = \text{a Constant}$$

$\times$ Tube Voltage. Taking current as constant 1 M.A. Roentgen Radiation per M.A. = a Constant $\times$ Square of Tube Voltage.

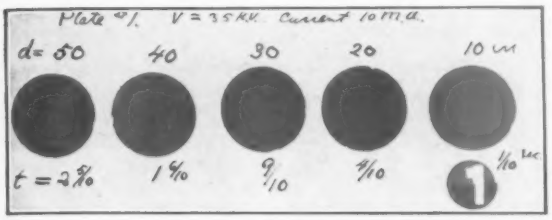


FIG. 1. Plate 1. (Lead mark 1.) Shows close equality of density when the reduction due to increased distance is compensated by increasing time of exposure. Distance increased from 10 inches to 30 inches, or 1 to 3, time is increased from 1/10 to 9/10, or 1 to 3^2.

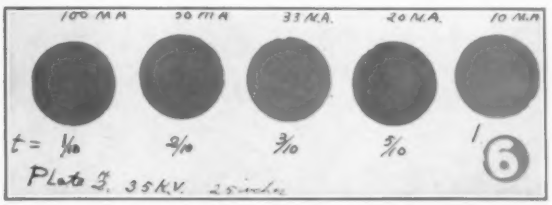


FIG. 2. Plate 2. (Lead mark 6.) Time for constant density when distance and voltage is constant is inversely as the current. 10 m. a. for 1 sec. = 100 m. a. for .1 sec.

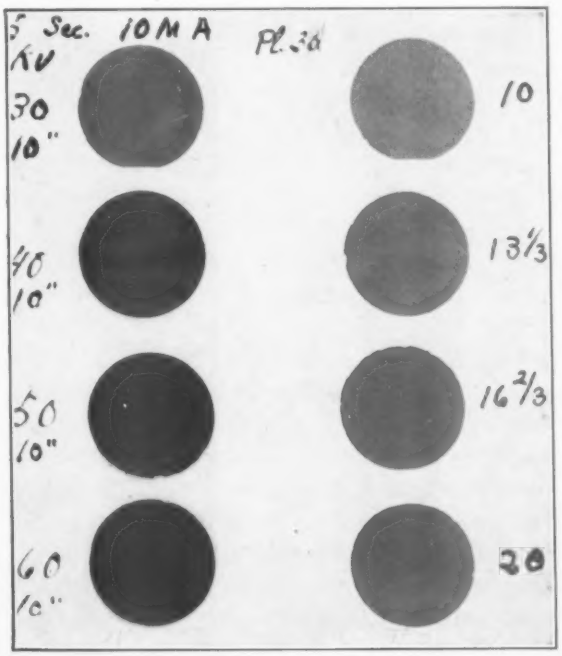


FIG. 3. Shows at the left where the series of four exposures were made with constant current (10 m. a.) constant time .5 sec., constant distance 10 inches, voltages of 30, 40, 50, 60 k. v. Right column same conditions of current, time and voltage, but distance increased in proportion to change in voltage, 40 k. v. = 30 k. v. × 4/3, 13 1/3 inches = 10 in. × 4/3.

Plate 3. Current constant, 10 M. A.
Time constant, .5 sec.
Left column constant distance.
Right column distance increased in proportion to increased voltage.

The very great increase in plate density as voltage is increased is here shown in part by the means used to compensate.

The quality of radiographs is generally more desirable on the lower voltages, but if fast work must be had it is only secured by the use of high voltage. Thus increasing from 30 to 60 K. V. will divide the exposure time by 4 while doubling current only divides it by 2. If we do both, the time is reduced to . In practice an approximate estimate of exposure time when

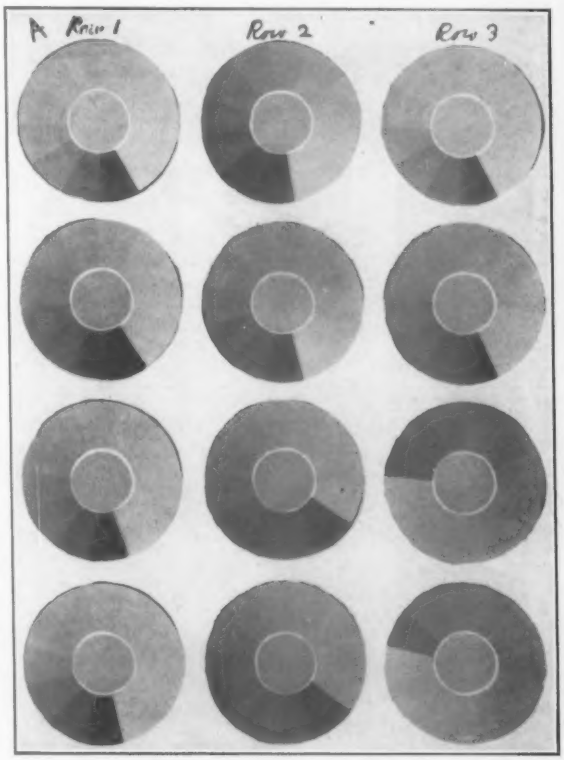


FIG. 4. Plate A. Row. 1. Constant voltage, variable current, time adjusted approximately. Row 2. Constant current variable voltage. Row 3. Current and voltage both varied, time adjusted to nearest tenth second.

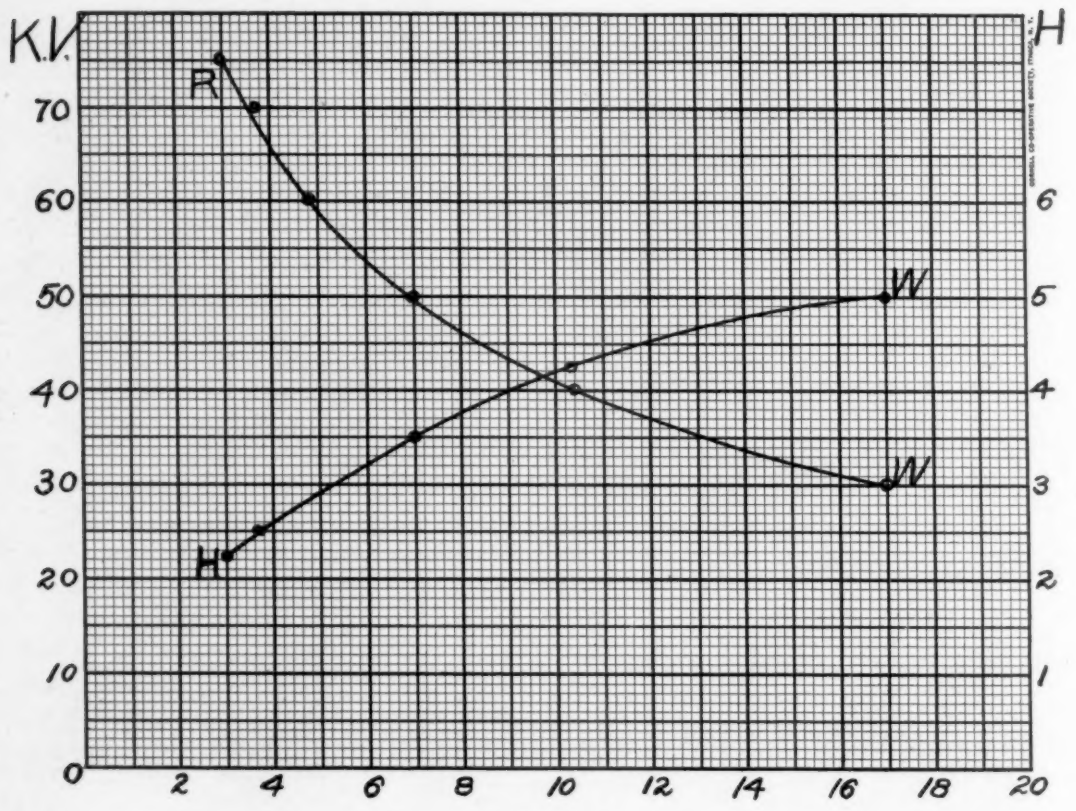


FIG. 5.

RW shows the relation between voltage and milliamperes, base line, tube current for constant photographic effect. A Kienböck exposed a definite time with 3 m. a. at 75 k. v. will match one exposed for the same time to 7 m. a. at 50 k. v.

HW shows the relative heat developed at the target for each running condition shown in *RW*. Thus 4 m. a. at 65 k. v. develops 260 watts, 17 m. a. at 30 k. v. gives 510 watts, but the photographic effect on a Kienböck will be the same as before.

we increase current or voltage above those for a known exposure time is quickly made mentally.

Thus an increase of current from 40 to 60 M. A. at the same voltage reduces the time required $\frac{2}{3}$ of the original. While increasing voltage from 30 to 50 would reduce time in ratio of 9/25 about to $\frac{1}{3}$; doing both gives $\frac{3}{9}$ or about $\frac{1}{5}$ the original time. When there is absorbing tissue in the path there is an even greater difference on account of increased penetration. The same results are found using a spark gap to estimate voltage, only it is not nearly so accurate or convenient.

To show this effect when absorbing material is present, a Benoist penetrometer was used with exposures as shown below.

Figure 4

Distance constant in all.

Column 1			Column 2			Column 3		
M.A.	K.V.	Sec.	M.A.	K.V.	Sec.	M.A.	K.V.	Sec.
30	30	2	30	30	2	30	30	2
40	30	1.5	30	40	1	40	40	.7
50	30	1.2	30	50	.7	50	50	.4
60	30	1	30	60	.5	60	60	.25

The evening up of exposures as regards the silver center is clearly shown. Observe that exposure time in column 1 decreased in proportion to increase of current.

In column 2 this reduction of time was greater, while in 3 at 60 M. A. and 60 K. V. only one-eighth of the time was used as on 30 M. A. and 30 K. V. The failure to "even up" on the aluminum portions is due to the greater absorption of this metal for rays from a low voltage tube.

One point of considerable importance follows relating to fluoroscopic work in reference to danger to the patient or operator. There is a great tendency to use very high voltage in this work because the work can be done with low current. Yet working with the Coolidge tube it seems to the writer that much better contrast is often to be had with lower penetration and larger current and with such contrast one can work quicker and with greater certainty. Those who have long been accustomed to the other method may doubt this statement, but invariably people of less fixed habits of vision agree with the writer. If the absorption of the photographic emulsion is any index of skin absorption then there may be much greater danger on small milliamperage at high voltage than the reverse.

In Fig. 5 R W is drawn for constant roentgen radiation absorbed by the plate at various voltages and current. It shows that 3 M. A. at 75 K. V. develops *approximately* the same roentgen radiation as 7 M. A. at 50 K. V. or 14 M. A. at 35 K. V. It follows that there would be no more danger in one case than the other for the same time of exposure if the skin absorbs even approximately as the plate emulsion. If a thin aluminum filter is used one may well select the desired *contrast* and then use the least current giving the requisite *brightness* so long as one is using the Coolidge tube where this control is possible.

The curve marked H W shows the relative heat developed at the target. It is clear that when using a gas tube, tending to unduly soften by heating, the small current, high voltage operation is required. This no doubt in part accounts for its use in dealing with these tubes. As the Coolidge tube will stand the power needed for fluoroscopy indefinitely the heat effect is of no special importance.

Cornell University, Oct., 1915.

DISCUSSION ON THE PAPERS OF DRS. SHEARER, COOLIDGE, AND HULL

Dr. Eugene W. Caldwell, New York City. Mr. President: Some papers are so complete that discussion is superfluous as well as impossible. That is true of the papers we have heard this morning, but the subjects covered are so numerous and the field so wide that it is impossible to take up more than three or four points in discussion.

Dr. Coolidge remarked that some of us resented making apparatus fool-proof, because then the technician could do all the work and there would be nothing for us to do. I really do not believe that any of us resents making apparatus more convenient; in fact, it would be appreciated, I think. We think highly of the wonderful work done by Dr. Coolidge and Dr. Shearer, and their associates, because it is going to make our work much easier. We do not object to the technician nor to making apparatus which he can handle, because the medical and surgical use of the *x*-ray demands more than appliances and technic. I, for one, would be very glad indeed to have every piece of apparatus made fool-proof, but to make a practical use of the roentgen ray we must know not only the apparatus, but the human body. Much experimenting has been done in the last six thousand years to make the human body fool-proof, but little progress has been made toward that end. We cannot expect to better it in our lifetime. For that reason it will not be sufficient to make apparatus fool-proof when we cannot eliminate the element of the human body. Within the past year or two an eminent professor of medicine, after a hurried trip through a few roentgen laboratories in Europe, delivered an address on this subject before a section of the New York Academy of Medicine. He told us then that there was no need for the roentgenologist; that he was entirely superfluous; that all that was necessary was a good technician. This man soon afterward sent a patient from his ward in the hospital to a photographer with the request that he give him treatment with the roentgen ray for ten minutes. It is too bad that this man could not have heard some of the papers read here this morning. Perhaps he would realize that there is work for others besides the technician, however valuable he may be.

I was delighted to have Drs. Shearer, Coolidge and Hull give confirmation to some pet hobbies of mine, especially the use of electrical measuring instruments and the use of continuous uniformly expressed electro-motive force for exciting tubes. It is true that they have taken away some of the things I hoped for from this force, but there is still foundation for the belief that we may have it available some time.

Dr. J. S. Shearer, Ithaca, N. Y.: The whole responsibility for all standardizing should not be thrown on the manufacturer. We are always inclined to put responsibility and blame on the other fellow. The manufacturer will meet you more than halfway if you will tell him what you wish.

Mr. Snook called attention to ionization in tissue. That is, of course, the only effect produced by roentgen rays, so far as we know at the present time.

I was very much interested recently to read a remarkable paper by Joly, calling attention to the extreme similarity between the action of the roentgen and gamma rays on the photographic plate, and their probable biological action. He traced some very interesting similarities, and for that reason

I have come to feel that for practical purposes the photographic measurement of the dose is of very much higher value than we have sometimes been inclined to believe. Such findings as have been carried on in Schenectady will require some time to filter out and become reduced to what is of the greatest practical importance. We need all the information we have and that everybody else can get. After all measurements are made, there is a lot of work to be done to adapt information to specific use. The simplification of the apparatus ought to give you more time to consider your patient. The handling of wonderful, beautifully finished apparatus, and the satisfaction it gives the patient, does not always conduce to the best interests of the specific case. It is the final result that counts, and it is the business of the manufacturer, the designer and the scientist to bring to you all of the essentials in the simplest form, so that you can get results.

One further point: There seems to be a good deal of misconception in some quarters. First, do not forget that putting in a filter does not add any high penetrating rays to the original beam. What you do is to reduce all of it, but the soft rays to a much greater extent than the others. Do not get misled by the great number of rays talked about and variously named. They all reduce to beta, alpha and gamma rays. It is a mistake to think that you cannot do anything until you have a non-fluctuating voltage.

As to standardization, I approve heartily of it, but as quickly as you standardize apparatus you have a great tendency to shut off development. Those things may work out in time, but do not standardize every specific piece of apparatus. But we should standardize the fundamental agent on which we depend for our therapeutic work.

Dr. W. D. Coolidge: Mr. Snook raises the question as to whether it is not possible with existing *x*-ray outfits to accurately reproduce results.

In so far as milliamperage is concerned, the answer is doubtless "Yes."

As to the matter of voltage measurement: I realize that at least three of the manufacturers have been using a voltmeter. As has been pointed out, however, in my paper, this method, while susceptible of accuracy, does not necessarily give it.

If the results of different operators are to be compared it is also necessary, as has been pointed out by Dr. Hull, that their tubes shall be operating on the same wave form. As the wave form on which the tube operates is determined by the characteristics of the dynamo furnishing the current, by the design of the step-down transformer outside the office, by the resistance of the supply wires running into the office, by the design of the *x*-ray transformer, by the type of control employed (resistance, inductance or auto transformer), by the design of the rectifier (in the case of a mechanical rectifier this involves the angular adjustment of the rectifier and the length of the various spark gaps as well), by the characteristics of the tube, and by the load. Each of the factors mentioned exerts its influence in determining what the resultant potential wave at the tube terminals shall be.

It seems to me that the problem of standardizing apparatus, to the end that a given technique can be reproduced anywhere in the world, is of the utmost importance, especially in therapeutic work. I should like very much to see it referred first to the United States Bureau of Standards. It could and should, of course, be taken up later by an international commission. Knowing the factors affecting the wave form and the measurement of potential, it would of course be a nice clean-cut problem for such a scientific bureau to learn by experimental investigation which of the various types of apparatus best lends itself to standardization.

Mr. Snook asked about our experience with thorium as a target material. We made up a Coolidge tube with a thorium target and operated it at high potentials—up to that corresponding to an 18-inch spark between points. At the time, we did not have a Bragg spectrometer, and therefore made absorption measurements, photographically, and with the ionization chamber. We did not get evidence in this way showing that thorium, for the same voltage, gave a penetration different from that given by a tungsten target. But for several reasons I distrust the absorption method for the measurement of high penetrating powers. In the near future we will refer the question to the spectrometer.

In connection with the problem of getting the maximum possible *x*-ray intensity from a given-sized focal spot, the question was raised by Mr. Snook as to whether we could help ourselves by refrigerating the target to a low temperature. We have not made experiments along this line and I, therefore, do not know.

I am very glad that Prof. Shearer spoke about auto-transformer control of voltage. We felt the need of it when, working with resistance control, we first attempted to accurately duplicate exposures. Unless the filament temperature is very accurately controlled, exact duplication of results is out of the question with resistance control, but, with a suitable auto-transformer, it is easy. The need of auto-transformer control is greatly reduced by the introduction of the new constant-potential transformer in the filament current supply, but its use is still a step in the direction of closer reproductibility of results.

Mr. H. C. Snook, Philadelphia: The résumé of the complicated physics of the Roentgen ray given by Dr. Shearer all of us have very much enjoyed. The physics of the roentgen ray is much more complicated to-day than it was a short time ago, on account of the many recent discoveries, some of which have been so well described this morning.

I want to emphasize one thing in connection with the physics of the roentgen ray which I believe has not been touched on, and that is the fact that whenever roentgen rays pass through any substance not only is secondary radiation produced within that substance, but also that substance emits electrons. These electrons are identical with the cathode particles inside the roentgen tube, and it appears that the velocity with which they emanate from substances radiated by the Roentgen ray is the same as that which the cathode rays had in the X-ray tube. These corpuscles emanate from the material not only on the side away from the X-ray tube, but also from the side toward the tube. The very great latitude of photographic emulsions, which great latitude we have had called to our attention to-day, is perhaps due largely to the great range in the quantity of the corpuscles emitted when the photographic emulsion is bombarded by the roentgen ray. I believe we will hear more about these phenomena in connection with the absorption of X-rays by various kinds of material.

I agree with Dr. Shearer in practically everything that he said, and I wish to emphasize an idea he to-day has emphasized and which he mentioned previously. I believe that automatic records will be of very great help and of importance to us. They are not highly developed as yet.

In the matter of cooperation, I fear that many of the manufacturers will not wish to cooperate in the matter of development to any very great degree, but cooperation is highly essential, and I believe that the matter of standardization is of the greatest importance to us. This question was brought up several years ago at the Cincinnati meeting, I believe, and effort was made to obtain some action. In fact, I think there was then appointed a committee on standards which was to consider this matter of standardiza-

tion. I hope that this question will be referred to the Executive Committee for investigation. It is important to have some beginning made in the direction of standardization at this time, and the Executive Committee is the proper body to conduct this investigation or refer it to some one to do so.

Dr. Hull's paper was very interesting, but he was unfortunate in giving us the impression at the outset that reproducibility is possible only under certain definite conditions in the use of high tension direct current, whereas his paper demonstrates that reproducibility is something that can be obtained with the use of either high tension alternating or direct current. He showed us that both the alternating and direct current can be standardized by the use of the volt meter and milliampere readings. I have stood for this principle for a long time, and I am very glad that Dr. Hull agrees with me. I am quite sure that Dr. Coolidge and Dr. Hull will develop the matter of measurement for us to a point where it will be very simple, easily understood, and thoroughly standardized.

The work Dr. Coolidge presented is simply stupendous. I am sure that we all owe him and his associates a vote of thanks for their fine, unselfish work. They have done much and made real progress. I should like to ask Dr. Coolidge whether he has been able to obtain any results from the thorium anti-cathode, which he mentioned in New York some time ago? We are all very much interested in the quality of the radiation and in the work Dr. Hull has done investigating the roentgen ray spectrum. He referred to the tungsten anti-cathode. I wonder whether by the use of tungsten there is any increase in the quantity of hard radiation over the use of platinum for target material. I would like particularly to know his ideas as to the radiation obtained from a thorium anti-cathode.

As to the digging of the focus spot with high tension direct current, Dr. Coolidge substantiates my general results. I found that when 90 milliamperes high tension direct current, nine-inch parallel spark gap with fine focus spot of definite size dug the tungsten at the focus spot, with the same conditions, the use of only 60 milliamperes pulsating rectified current was sufficient to produce the same digging of the tungsten. With high tension direct current we also find it easy to remelt the focus spot and produce the phenomena he described to you. We use a machine with ten per cent. fluctuation, high tension direct current, as compared to one-tenth of one per cent., referred to this morning.

I should like to have Dr. Coolidge tell us the limitations in connection with better refrigeration of the target as a means of obtaining higher intensities of energy. Also why that bright ring appears around the filament in that sharp focus tube he showed us. I agree with him that the standardization of the X-ray tube can be looked for, and that we can accomplish it with equal facility either with some type of electron tube or some type of gas tube. Some years ago Lilienfeld and Fuerstenau did valuable work developing the electron tube, which I think the war may not have interrupted, and we may hear something from it later.

I should also like to ask about the ball-bearings in the tube with the rotating target. Is there evolution of gas due to the rotation of the ball-bearings? Are they ordinary steel balls?

THE BIOLOGICAL EXPLANATION OF X-RADIATION EFFECTS *

By A. RICHARDS, University of Texas, Austin, Texas

DURING all the years that have passed since the study of the effect of x-rays on living matter began, very little progress has been made toward solving the problem of what the real nature of the changes produced in cells and tissues is. Many things are known about the conditions under which a great variety of changes may be produced, and the changes themselves have been quite completely classified; yet the mechanism by which the disturbances have been brought about remains unexplained.

Of the proposed explanations, three theories are perhaps most important.† The first is that of Schwarz, who erected on the basis of his experiments the lecithin hypothesis. He found egg yolk to be decomposed by the action of radium rays, and thought that the lecithin which it contains in large quantities was broken up; since lecithin is found quite generally in animal cells, its decomposition in exposed cells would be unfavorable to normal cell activities. According to this, the effect on chromosomes and other cell organs is an indirect one (where it occurs at all), and is a secondary result of the lecithin decomposition. The hypothesis was not based on rigid chemical determinations.

Directly opposed to this is the theory of Hertwig and his school, developed after many long and painstaking experiments. In the Hertwig laboratory at Berlin the first comprehensive studies of the effects of radioactivity from the cytological standpoint have been made; these have formed the basis for this second theory. It was early observed that the cell organs, with the single exception of chromatin and chromosomes (that is, spindles, asters, centrosomes, etc.), showed little injury due to the action of the rays. From this, it was assumed that the injury is a direct one on the chromatin of the radiated cells, and that the seat of the injury, if not exclusively in the chromatin, is certainly chiefly there. Artificial fertilization and crossing experiments added strong evidence for this assumption.

The third explanation is based upon a theory of enzyme modifiability. A number of experiments have been reported in which radium rays were found to influence the rate of enzyme reactions, and these facts in connection with certain cytological observations led Packard to elaborate this theory in one form. He believes that the effect of radium on the chromatin is an indirect one, the rays "activating autolytic enzymes which bring about a degeneration of the complex proteids." He further supposes that while many enzymes may be activated, "the lytic enzymes are more stimulated than those which play a synthesizing rôle." A slight radiation results in acceleration and the synthetic processes may be supposed to be stimulated more than destructive activities.

In a series of researches, the writer has sought further information concerning the real nature of the changes induced in the organism by radioactivity, and has attempted to find evidence corroborative of one or the other of these theories. Since the first announcement of the lecithin theory, no new

* Contribution from the School of Zoology, Univ. of Texas, No. 128.

† For a general discussion of these theories with references, see the writer's paper in *Science*, N.S., Vol. XLII, p. 287, Sept. 3, 1915.

evidence of a positive nature has been put forward in favor of that view, while there are many points which are not in accord with it. It may, therefore, be regarded as overthrown. For the second view there is much positive evidence that the chromatin is greatly injured, but there is no question at the present time that other structures are affected, and it is by no means proven that the chromatin is the chief seat of the injury, as will be shown below. For the theory of enzyme modifiability further evidence has been brought forward, and some such explanation becomes increasingly probable. But even this does not offer any real explanation of the mechanism by which radioactivity is able to bring about accelerative or inhibitory changes, as the case may be, in the life process of the organism. For this we must doubtless look to further research along the lines of physical chemistry.

Among the writer's earliest observations pertaining to this problem were those on the effect of *x*-rays on the development of the eggs of the pond snail, Planorbis,* these had to do particularly with the rate of division. As a result of these experiments it was determined that the first effect of exposure, if the mitosis has already started, is to quicken the speed with which mitotic activity takes place. Following this phase of acceleration, a phase of depression sets in, and the end result is to retard greatly the development of the egg. The phase of acceleration always lasts through a complete mitotic cycle, and may extend over two or more. In the depression phase, a second acceleration may be induced by a renewed exposure, but it is less effective than the first. These effects follow when the exposure has been made during the progress of a mitosis and most markedly during the early stages of spindle formation; if, however, the stimulation is made during the resting stage, only slight results may be expected. These results are made clearer by comparing the exposed eggs with controls run under exactly the same conditions in all particulars except with regard to the exposure. If the exposure is made during the first cleavage division, the controls will develop more slowly than the experiment up to the four or eight cell stage; the depression phase now sets in, and the experiment is slowed down to the rate of the control, then becomes slower, until by the time the twenty-four cell stage is reached the control is appreciably ahead of the experiment in development.

It has been mentioned above that the rays of radium had been found efficacious in altering the activity of enzymes. Experiments of a similar nature with *x*-rays were practically lacking. The writer undertook, therefore, to measure the change that could be induced in a given time in the digestion of egg albumen by pepsin, and of starch by diastase when exposed to the action of *x*-rays.* The first of these experiments was carried out according to the process of Mett, and the amount of egg albumen digested measured under the binocular microscope. One portion of the pepsin solution was retained for a control, and the remainder (in an experiment which may be taken as an illustration) was divided into parts which were radiated 4, 10, 20, and 30 minutes respectively. The Mett tubes were then placed in the solutions at a constant temperature and digestion allowed to proceed for a given time. In this experiment, the digestion in the 4 min. solution was 12% greater than in the control at the end of the given time, while in the other solutions digestion was 5%, 10%, and 15% less for the 10, 20, and 30 minute radiations respectively, Although the actual difference was slight, it occurred always in constant relation to the control and to the length of the exposure. From this it appears that a short radiation has the effect of accelerating the activity of this enzyme, while longer radiation is in-

* *Biol. Bull.*, Vol. XXVII, Aug., 1914.

* *Amer. Jour. Physiol.*, Vol. XXV, Sept., 1914.

hibitive; between these two strengths lies a point at which the radiation is non-effective. This generalization from the pepsin experiment was exactly borne out by the data from the diastase test, for more starch was digested by the diastase exposed to short radiation than by the control solution (tested by Benedict's method, No. 2) and less than the control by that created with long radiation. Here then is a case in which a substance of organic nature, but not chromatic, is injured as the result of radiation, contrary to the Hertwig hypothesis.

The behavior of "fertilizin" when exposed to the action of *x*-rays is another case of similar nature. Fertilizin is a substance, obtained from the eggs of starfish or sea-urchins by extraction with water, which has the power of agglutinating and activating sperm of its own species. This substance was studied by Miss Woodward and the writer * with regard to its capacity for undergoing modification under the action of external agents, of which *x*-rays may serve as a type. It is extracted from the egg at a time when the chromatin is at rest; it is then decanted and the fertilizin, not the eggs, radiated. Thus the chromatin can play no part in this experiment. It was found that this cell extractive is definitely modifiable by radioactivity in a manner quite similar to the enzymes just described: a weak radiation increased its activity, as measured by its power to agglutinate sperm, while a strong radiation proved inhibitive. Here, then, is one cell extractive (and we have no reason to think that others might not be similarly influenced), which is reactive to *x*-rays aside from any effect the rays may have on chromatin or other nuclear substance.

During the last several years attempts have been made to explain many vital phenomena as due to changes in the permeability of cell membranes to various substances in solution. Semi-permeable membranes permit the passage of certain substances, but not others; if the permeability be changed for any of these substances we may expect a difference in the activities of the cell due to the penetration of a different set of chemical substances. The suggestion offered itself that *x*-radiation may act by causing such changes, for instance, in the Planorbis eggs already mentioned. To test this possibility, the writer performed experiments along several different lines,* as follows: It is a well known fact that when the larvæ of Arenicola, a marine worm, are brought into any substance that causes permeability changes, a yellow pigment is extruded; under the influence of radiation, no pigment was given off by these larvæ. At the present time it is fairly generally assumed that agents which will cause the development of marine eggs without fertilization (that is, cause artificial parthenogenesis) do so by cytolyzing the cortical layer of the cell protoplasm, and that the cytolysis in its turn is correlated with permeability changes in the egg membrane. Positive results from experiments to cause artificial parthenogenesis would imply, therefore, changes in permeability of the cell membranes. All attempts to bring about this phenomenon by radiation uniformly failed, indicating that no such changes occur. Finally, the indicator method with various modifications was used; cells were stained with a neutral indicator (neutral red, here) so that a color change would indicate the presence of a base or an acid as soon as it penetrated the plasma membrane. In all cases the substances in solution were found to enter the control, non-radiated cells, after exactly the same interval as in the case of the ones exposed to the rays. Thus the radiation did not bring about changes in the permeability of the substances which were used in the experiment. The conclusion seems warranted, therefore, that permeability changes are not the causal factors in the events which follow radiation.

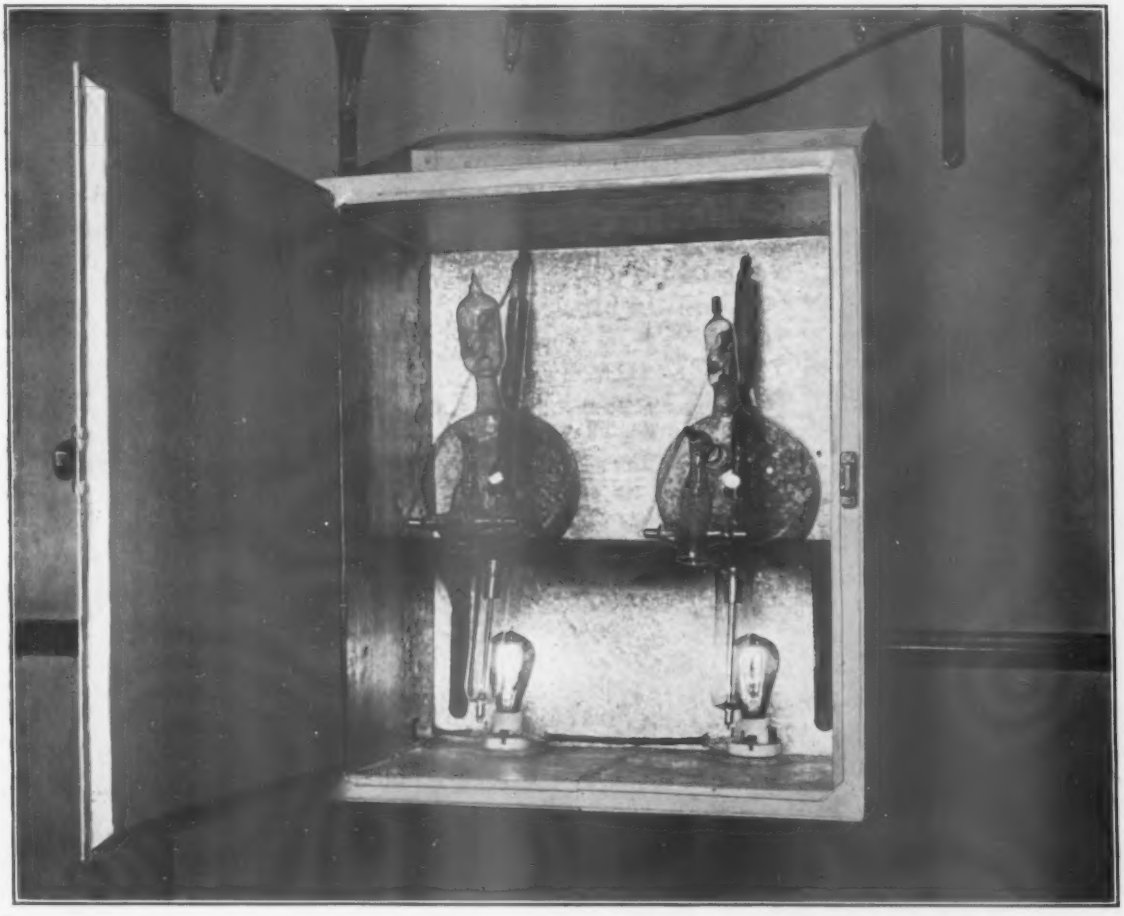
* *Biol. Bull.*, Vol. XXVIII, March, 1915.

* *Amer. Jour. Physiol.*, Vol. XXXVI, March, 1915.

"The facts as they are at present known in regard to the effects of radioactivity on living matter, show that life processes are subject to marked changes under the influence of radiation, a slight exposure being accelerative in most cases, while a more intense treatment is inhibitive or destructive. As a causal factor in these effects, the demonstrable injury to the chromatin of the cells is undoubtedly important; but there are also good evidences that the modifiability of enzymes under the action of the rays likewise plays a considerable part either directly or indirectly in the resulting injury."

DEVICE FOR USE IN CONNECTION WITH THE HYDROGEN TUBES

By JAMES T. CASE, M. D.



IN using hydrogen tubes, the writer has noted considerable difficulty in maintaining a given penetration unless the tube has been used long enough to get it warmed up. This preliminary warming up consumes so much time that a method was sought for keeping the tubes warm.

The idea occurred to the writer that the tubes might be kept warm in a thermostat arrangement. Hence a metal box was constructed, as illustrated in the accompanying cut. The box contains two lamps, so that with the doors closed, the tubes are kept warm.

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THE ATTITUDE OF THE MEDICAL PROFESSION TOWARD ROENTGENOLOGY

AS the profession becomes more and more accustomed to the routine employment of the roentgen method, and as the men who specialize in the use of this wonderfully helpful diagnostic agent, through experience and accuracy gain more of the confidence of the referring physicians, a change will doubtless be brought about in the attitude now generally maintained toward *x*-ray work. The roentgen laboratory will no longer be considered a photograph gallery, presided over by a medical photographer, but rather a medical examining room, where the physician skilled in the use of the *x*-ray secures additional special information. The evidence thus afforded must be collated and checked up by, as well as check, the findings secured by other clinical means. Plates will then be made less and less frequently. The fluoroscopic observation of the trained eye will bear more weight in contributing to the diagnosis. Less dependence will be placed upon the photographic record of static conditions and more upon the written record made at the time of fluoroscopic observation. Fewer "pictures" will be demanded, less time will be consumed in the purely mechanical and laborious side of roentgenology, and more time will be left for the development of finer points of diagnosis.

The average physician's idea of the chief qualification which a prospective roentgenologist must possess is the ability to make "pictures." It is still an every-day occurrence for patients with gastric and intestinal lesions to be referred to the roentgenologist for an *x*-ray "picture." Roentgenology needs men of experience in clinical medicine who are willing to give the necessary time

to the technical preparation for this class of diagnostic work. *A man who is not medically trained is ipso facto not qualified to practice roentgenology.* Under present conditions, the evolution of a roentgen specialist (?) is very simple and altogether too easy,—a machine, with somebody to run it; a tube, a few lessons from the salesman on how to turn the current on and off, and lo, a roentgenologist! Even some recent graduates in medicine have felt that this science is so simple and mechanically easy that it is not necessary to give time to the necessary preliminary training before undertaking roentgen diagnostic work.

The skilled roentgenologist must have a broad experience in clinical work to enable him to correlate the patient's physical symptoms and the history with the roentgenologic findings. The recognition of gross gastric lesions is comparatively easy, even in unskilled hands. Such definite lesions as penetrating ulcers, gross pyloric obstruction, extensive carcinoma, or true hourglass stomach, are not difficult of recognition. But, as has been emphasized by so many eminent medical men, the great majority of patients exhibiting gastric symptoms are not really the victims of gastric disease; they are suffering from some other abdominal condition, involving the gall bladder, the appendix, the colon or some other organ. Careful effort must be made to avoid confusion between conditions which are physiological or only spastic, and those which are due to organic lesions.

One can hardly hope to excel in all fields of roentgenological diagnosis. To be expert in the examination of the alimentary tract, one must have enjoyed special advantages for clinical observation of disease of the alimentary tract. In fact there is already a tendency among roentgenologists whose work has become firmly established to direct their special activities into special lines.

J. T. C.

We take pleasure in noting the preliminary notices of the appearance of the American Atlas of Stereoroentgenology which is to be published quarterly under the auspices of the New York Roentgen Society. If the publication fulfills the promises made in the prospectus, it certainly will be a welcome contribution to American medical literature. One of the great difficulties which the student of roentgenology labors under, is the scarcity of well illustrated literature in the English language. This, of course, is consequent upon the newness of the art, and will tend to be gradually remedied as time progresses.

ANNOUNCEMENTS

A mid-winter meeting of roentgenologists will be held at Hotel Chalfonte, Atlantic City, N. J., January 21st and 22nd, 1916.

PROVISIONAL PROGRAMME

(No other will be printed, but changes may be made at the meeting.)

Informal discussions will be the rule at three sessions.

Friday Evening, 8:15

Chairman, Dr. George C. Johnston

(a) Pulmonary Tuberculosis: What is the present value of the roentgen ray in its diagnosis?
Leaders, Drs. Daland, Dunham, Cole, Holmes, Heise and Manges.

(b) Workingmen's Compensation Laws as related to roentgenologists.
Leaders, Drs. Percy Brown, Reu, Eastmond and Palmer.

Saturday Morning, 9:30

Chairman, Dr. H. W. Van Allen

(a) Progress and Prophecy.
Leaders, Dr. Coolidge, Dr. Caldwell, Prof. Shearer, Mr. Snook.

(b) Roentgen Therapy and its Adjuvants.
Leaders, Drs. Boggs, Pancoast, Holding, Stern and MacKee.

Saturday Afternoon, 2:30

Chairman, Dr. W. H. Stewart.

(a) Bone Syphilis; Bone Tuberculosis; Chronic Osteo-arthritis: To what extent is positive diagnosis by roentgen ray possible? Sources of Error?
Leaders, Drs. Albee, Baetjer, LeWald, Jaches and Hammond.

(b) Gall Stones. What further may be said regarding the Sources of Negative and Positive Error in their roentgen diagnosis?
Leaders, Drs. Case, George, Pfahler and Selby.

The leaders in each topic will be followed by open discussion at the discretion of the Chairman.

At the beginning of the Saturday afternoon meeting a business session will be held, to determine the time and place of the 1917 meeting, and to provide a committee therefor.

No formal papers are listed but such may be read by permission of the meeting.

Saturday Evening, 8:15

Lantern Slide Exhibit—Chairman, Dr. A. L. Gray

Limited to 15 slides for each exhibitor.

If necessary, some will be shown Friday evening.

Exhibitors will be listed in the order that cards are received.

NOTES

The Hotel is making special rates.

Make reservation as early as possible, and directly with the Hotel Chalfonte.

Manufacturers wishing to exhibit will please make their arrangements directly with the Hotel. No other fee will be demanded.

Do not neglect to bring "The Ladies." *Come along with us. We need you and you need the rest.*

COMMITTEE

Massachusetts—Dr. Brown and Dr. George, Boston; Dr. Van Allen, Springfield.

Rhode Island—Dr. Hammond, Providence.

Connecticut—Dr. Heublein, Hartford.

New York—Dr. Cole, Dr. Jaches, Dr. Imboden and Dr. Eastmond, Brooklyn; Dr. Burch, Syracuse; Dr. Palmer, Rochester; Dr. Reu, Buffalo.

New Jersey—Dr. Wescott, Atlantic City.

Pennsylvania—Dr. Pfahler, Dr. Pancoast, Dr. Manges and Dr. Bowen, Philadelphia; Dr. Johnston and Dr. Boggs, Pittsburgh.

Maryland—Dr. Baetjer and Dr. Ashbury, Baltimore.

District of Columbia—Dr. Selby and Dr. Merrill, Washington.

Virginia—Dr. Gray and Dr. Tally, Richmond.

The mid-winter meeting of the western members of the American Roentgen Ray Society will be held in Detroit, Michigan, February 5th, 1916, at the Hotel Statler. The committee of arrangements consists of Dr. Rollin Stevens and Dr. George Chene. These meetings have always been quite informal, but the committee has planned to have presented much that will be interesting and instructive. The Detroit members extend a most hearty invitation to all the members to meet at the above mentioned date. Members wishing to contribute to the program will write Dr. Rollin Stevens, the Stevens Bldg., Detroit, Michigan.

Department of Translations and Abstracts

Editor

James T. Case, M.D., Battle Creek, Mich.

ABSTRACTS

Roentgenography of Gas Phlegmons. B. Doehner, M.D. (Munch. med. Woch., vol. 62, No. 38, Sept. 21, 1915, p. 1305.)

Referring to the observations made by Martens (Berliner med. Wchnschr., 1915, 29) and Finkh (Deutsche med. Wchnschr., 1915, 20), the author adds a case which had been referred to his new "Military Roentgen Wagon" for examination.

Patient was shot in the calf. Roentgen examination 20 hours later. Diagnosis: Gas phlegmons. Operation same day. Malodorous pus in the deep musculature, gas bubbles and rags. The projectile was found deeper near the tibia, enveloped in rags. Recovery in 4 weeks.

This case almost demands that every shot wound be examined roentgenologically, just as every wounded soldier is inoculated for tetanus. The author has made a few valuable observations in this and other cases. Exposures made with the intensifying screen do not show the gas phlegmons with certainty. They require soft tubes with long exposures in two directions. Air spaces in the bandage may simulate gas phlegmons, especially when "ortizon" powder or rods were used. Consequently, every plate should be immediately developed in order to follow up any suspicious markings by an exposure without the bandage.

The author thinks it useless to determine gas phlegmons in the abdomen by roentgenology, as it can not be done with certainty.

Is Exclusive Radiation Permissible in Operable Carcinoma of the Uterus? S. Flatau, Nurnberg. (Abst. Zentralbl. f. Gyn., Nos. 35, 36, 1915. Ref. Munch. med. Woch., vol. 62, No. 39.)

The author answers this question in the affirmative, taking issue with Hofmeier for the opposite view expressed in the *Zentralblatt f. Gyn.*, 1915, No. 1. Hofmeier based his warning on the experience of a certain case. Flatau replies with another case, in which a woman with an apparently incipient cervix carcinoma died of a lumbar marrow metastasis in spite of surgical interference. Flatau believes that an incipient carcinomatous focus will be totally destroyed with radium, and since December, 1913, he has not performed any more radical operations for carcinoma of the cervix uteri. This question, which has become active since the Halle Gynecological Conference, awaits elucidation by further experience.

Contributions to the Physiology of the Stomach. XXVI. The Relation Between the Digestion Contractions of the Filled, and the Hunger Contractions of the "Empty" Stomach. F. T. Rogers and L. L. J. Hardt, Chicago. (*Am. J. Phys.*, vol. XXXVIII, No. 2, p. 274.)

Rogers and Hardt, with the assistance of Rowntree, in a series of experiments on man and dog, first have attempted to differentiate the hunger contractions of the stomach from its normal motor activities occurring during digestion, and, second, to deter-

The Abstract Editor is indebted to the Zentralblatt für Röntgenstrahlen, Radium und verwandte Gebiete for material aid in the production of abstracts of many of the foreign articles.

mine whether or not the same conditions apply to man and dog.

The movements of the stomach were investigated with the rubber balloon and the *x*-ray. Two balloons were used, one being enclosed within another of the same size, the walls being separated by a layer of bismuth paste. To study the genesis of the hunger contractions, the rubber balloon, which was connected by small sized rubber tubing with the recording manometer, was swallowed shortly after a meal and continuous graphic records of the intragastric pressure variations were made, until after the onset of the typical hunger period. The graphic tracings were made with simultaneous direct fluoroscopic observation.

The records showed that the fundus was quiescent immediately after eating a meal. Within a half hour tonus variations appeared. These small waves gradually increased in intensity and occasionally became more rapid. When the stomach was nearly empty the waves became more marked and there usually appeared superimposed upon them stronger contractions which increased in vigor and were felt by the subject as hunger pains.

In the dog the weaker type of hunger contractions began as a contraction in the cardiac end of the stomach and passed down toward the pyloric end as a rapid peristaltic wave. In the very vigorous contraction the wave spread over the stomach so rapidly that it was difficult to decide whether there was contraction of the fundus as a whole, or a very rapid peristalsis.

When the observations were made of the human stomach, the graphic record confirmed the hunger pain felt by the subject in every case. When the hunger pang was felt, a series of constrictions passed rapidly over the balloon. Beginning at the cardiac end, they swept rapidly toward the pyloric end, increasing in strength as they proceeded. It was readily seen that the hunger contractions are powerful peristaltic contractions, which arising at or near the cardiac sphincter, swept downward over the entire stomach. During a typical hunger period the stomach exhibits movements which resemble very closely the movements which have been described by clinicians in patients after a bismuth meal as hyperperistalsis, but described by Cole as normal peristalsis of a stomach that contains small quantities of food.

The essayists conclude as follows:

1. Both in man and in the dog, the fundic end of the stomach, during normal digestion, exhibits a slow tonus rhythm of one to three minutes' duration. During the emptying of the stomach and the onset of the hunger period, this tonus rhythm becomes more vigorous.

2. In the dog after thirty-six hours' starvation, the stomach is markedly hypertonic; a vigorous hunger contraction is a contraction of the fundus as a whole.

3. In man after fifteen hours' starvation the hunger contractions are vigorous peristaltic contractions in groups of 2-4, superimposed upon the slow tonus rhythm. They begin at the cardiac end of the stomach and sweep over the whole stomach.

4. A given inhibiting agent does not necessarily have the same effect upon the different types of gastric contractions; thus the pyloric peristalsis is the most resistant to reflex inhibiting influences; fundic peristalsis is the least resistant, while the tonus rhythm occupies a position between the two.

The X-ray Treatment of Fungating Epithelioma with the Introduction of "Progressive Filtration." Christopher Kempster, M.R.C.S., London. (*The Lancet*, Oct 16, 1915, p. 867.)

The author concedes the advantage of the present almost universal custom of treating malignant growths with massive doses of *x*-rays delivered through thick filters in order that the surface may be protected from

the short, soft surface rays, and also in order to secure a more equal distribution of the dosage to the superficial and deep cells of the growth. He remarks, however, that the results obtained are unnecessarily slow.

From practical experience he has observed that the cases that give the best results are those that have been treated by what he has termed the "progressive filtration" method,—that is, the gradual introduction of filters of progressive thickness. He believes that the surface of a fungating epithelioma needs the short, soft rays which seem to have a singularly rapid atrophic effect when administered in full pastille doses. He therefore delivers to these growths a full pastille dose of the rays without any filter at a distance of 10.6 cm. from the anticathode, the healthy surrounding tissues being carefully protected. This dose is repeated at weekly intervals for two or three doses, according to the thickness of the fungation, by which time the fungation has usually shrunk in a remarkable manner. A filter of one millimeter of aluminum is then introduced and a further full pastille dose delivered at two or three weekly sessions, the pastille being on the level of the skin surface, the dose being measured according to the method of Hampson. By this time the fungation will, in most cases, have disappeared, and a fairly healthy dry surface will be present. At the next two or three weekly seances the filter will be increased to 1.5 mm., together with a few layers of lint between the filter and the patient, a full pastille dose being given each time. After the next two doses, the filter is increased to 2 mm., where it usually remains.

By adopting this method the writer has secured a larger number of satisfactory results, the disappearance of the tumor being rapid and the site of the lesion presenting a normal appearance free from induration and practically free from scar. The details of three illustrative cases are cited.

Prostatic Calculus. **Francis Huber, M.D., New York City. (New York Medical Journal, Sept. 25, 1915, vol. cii, p. 643.)**

Huber says that if a roentgenogram of the *unemptied* bladder, exposed with the patient in the level supine or in reversed Trendelenburg position, shows a shadow or group of shadows in the region of the neck of the bladder, and a second roentgenogram, exposed with the patient in the Trendelenburg position, and the roentgen rays passing in the same relative direction, shows the shadow in the same place as before, the stone or stones are fixed in the prostate or the prostatic urethra or in a diverticulum behind the prostate. He suggested to roentgenologists this technic in order to differentiate vesical from prostatic calculi.

The absence for a long period of time of all signs of local infection in a case of purulent prostatitis is strongly suggestive of a calculous etiology.

Treatment of Grave Fractures by Means of Roentgen Irritation. **M. Fränkel, M. D., Charlottenburg. (Münch kl. Woch., No. 8. Ref. Deutsche med. Woch., vol. 41, No. 11, March 11, 1915.)**

Roentgen doses selected for the treatment of fistulæ have a stimulating effect upon the granulations, exerting a growth-promoting influence due to the more rapid closure of the wound. The same effect can be observed in the healing of wounds by experimentally exposing several wounds to the rays and leaving one wound unexposed. The rapid healing of grave fractures by exposing them to high roentgen doses was astonishing.

Protective Devices for Roentgenologists and Assistants. **Albers-Schoenberg and Lorenz. (Deutsche med. Woch., vol. 41, No. 11, March 11, 1915, p. 301.)**

This article deals with the protection of the physician from the roentgen rays them-

selves and from unscrupulous patients who would hold him responsible for real or imaginary injuries that are not his fault.

The forensic part may be dealt with first.

A physician using roentgen rays in his practice must be able to prove in the case of an action for damages against him that he has had a competent training. This is an old demand of Albers-Schoenberg; and Kirchberger is right in his book, "Die rechtliche Beurteilung der Roentgen- und Radium-schaedigungen," when he says that a short course of instruction, such as is given by factories, is hardly sufficient. The physician who uses roentgen rays must be expected to follow the most recent developments in his specialty. He should know the mistakes committed by others that have led to actions for damages, and he should avoid the same. If he neglects to do so, he may be held guilty of negligence. Kirchberger demands, based upon court decisions, that the physician will use apparatus of good quality and that he be familiar with its use. Technical errors and gross carelessness in dosage, protection and examination of patients, are not allowed to occur.

Some individuals seem to have an idiosyncrasy against roentgen rays, as burns will occur in their treatment in spite of all precautions (Roentgen Taschenbuch, 1913, Case Grashey). In order to be protected against cases of this kind, which may ruin the very existence of a physician, there is nothing left but to take out an insurance against demands for *x*-ray compensation. This should be done by every roentgenologist. The insurance company will hold him harmless whether he has made a mistake or not. It frees him from the care and unrest of conducting a lawsuit; it prophylactically assures the composure necessary for the competent conduct of his responsible activity.

The acts of his assistants may involve the roentgenologist in damage suits, which may be guarded against by constant supervision and insurance. Thus he will be safe at least as far as the civil law is concerned.

The roentgenologist is also responsible for the safety of his assistants. Unless he has provided for sufficient instruction and superintendence, he may be held responsible for injury (such as sterilization of female assistants, injuries due to switching of currents, glass splinters in tube explosions, etc.). The physician may extend his insurance to include also cases of this kind.

Some jurists (Schroeder, Kirchberg) doubt the validity of a waiver, exonerating in advance the roentgenologist of any medical responsibility, although the practice is in general vogue. The insurance, therefore, is a true blessing, and the physician should see to it that his policy has no flaws.

Albers-Schoenberg recommends the following wording of the policy (Roentgen Technic, 1913): "The insured is a specialist in roentgenology and director of a roentgen institute. His duties include diagnostic examinations and therapeutic treatment of patients by means of *x*-rays, conducting courses of instruction in roentgenology for physicians, nurses, etc. Whatever demands may accrue from his activity as a roentgenologist must be covered by this insurance; likewise any demands which may be made upon him owing to mistakes made by his staff (assistant physicians, volunteer physicians, nurses, etc.)."

The policy should have retroactive power and also include substitute cases, because here a different set of apparatus is involved.

The next point concerns the protective measures against injury from the roentgen rays. To correctly apply such protection, presupposes the knowledge in how far the human body is susceptible to roentgen rays. The fact of the rays exerting an injurious effect was pointed out by Freund as early as 1896. In the early stages of the young science, insufficiently exhausted tubes with soft rays were used, causing very grave skin injuries (ulcerations, epilation of hair and

beard). Many roentgenologists had to bear the brunt of their own experiments, and many sustained ulcers, nearly all dermatitis, especially of the hands, which they innocently used as a test object for determining the quality of the rays. As the rays continued to exert their effect, deep destruction of tissues occurred, such as vessels of the corium and subcutis, atrophy of the skin and teleangietasis. Arrested function of the sebaceous glands leading to brittleness of the skin, caused rhagades and subsequent carcinoma. Up to 1913, Lazarus counted 74 cases of roentgen carcinoma and Schoenfeld reports that among 54 cases there were 24 physicians, 8 of whom died of the consequences of the injury.

As the technic advanced, the tubes were better exhausted, and injurious effects became noticeable from the deep effects of roentgen rays. It is, therefore, the duty of the roentgenologist to protect himself and his assistants from many dangers, especially as with the use of high evacuated tubes very hard rays are applied nowadays which will easily penetrate insufficiently protected substances.

Protective measures were elaborated gradually and systematically. The heavy metals were among the first substances found to be particularly capable of absorption. At first, various layers of tinfoil were used with varying success. Leather, as the nearest substitute of human skin, was supposed to retain the rays. We are indebted to Kienboeck and Holzknecht for having tested with the aid of the radiometer the absorptive faculty of tinfoil and to have freed many roentgenologists from the dangerous error of believing that the electrostatic charge of the protective material or the electricity communicated to the body from the charged glass wall of the roentgen tube, constituted the injurious factor.

Lead came rapidly into use, and the rule was accepted that the substance having the highest specific and atomic gravity furnished the best protection. But lead was disliked on account of both its poisonous properties and its uncleanliness. Kienboeck and Grünfeld, therefore, suggested to envelope the lead in rubber, and this has been the origin of our present-day rubber protective substances.

In 1903, Gundelach invented his lead-glass, which is manufactured to-day by many houses in an improved form. Walter examined the heavy metals, lead, silver and tin on the fluorescent screen and photographic plate in order to determine first their absorbing property and subsequently their technical and economic practicability, taking into consideration their surface extent, thickness, weight and expense. Taking lead as a unit, he arranged the other substances in relation thereto and found that the generally acknowledged axiom, that the substance having the highest specific and atomic gravity possessed the highest absorbability for *x*-rays, was not well founded. He found that in greater thicknesses, silver supersedes lead in the ratio of 0.92 mm. of silver to 1 mm. of lead, and that the protective effect was by no means proportionate to the thickness, many more rays being absorbed in the first strata than in the last. Or, putting it reversely, as the power of penetration rises the deeper the rays penetrate.

For the sake of completeness it may be mentioned that pastes containing bismuth, aluminum and lead are used to protect healthy parts, especially by dermatologists. More recently the leucoplast sheetlead, after Fuerst, has accredited itself well. A sheet of lead 1 mm. thick is covered on one side with Beiersdorffer's leucoplast stick paste. This adheres well to the skin and serves to hold the protective lead in position on inclined surfaces. P. Krause replaces lead by iron and barium preparations, which, although they have the advantage of cheapness, have not yet met with favor.

With the aid of these protective sub-

stances, the roentgenologist has to protect himself and his staff from the direct primary and also the secondary rays. The investigations of the latter are not yet concluded. Albers-Schoenberg found (Fortsch., 1913, 21) that small doses of characteristic secondary aluminum rays had no effect on rabbits' testicles. Since then Krüger (Strahlentherapie, 3) claimed to have observed arrest and irritation of development in the germinating power of peas which were exposed to secondary rays. Rabbits' testicles likewise showed the typical changes. Caution should therefore demand "absolute roentgen protection" (Albers-Schoenberg) for the operator and his staff.

Many authors content themselves with absolute protection for therapeutic purposes only. It is wrong to make such a distinction. In spite of tubes placed in lead boxes, protective aprons, glasses, gloves and screen, the operator can not prevent being exposed to the rays. For this reason, the orthodiagraph is a suspicious instrument on account of the necessary length of exposure, and it can be replaced in heart measurements by the simple determination of the two extreme marginal points by means of the central ray. To determine the shape of the heart in its true size, the horizontal and vertical teleroentgenography can be used. In order to expose himself as little as possible to the direct rays in transilluminations, the operator will do well to examine the patient, preferably, in the horizontal position and to apply the rays upward, i.e., to use the trochoscope whenever possible.

The best and most absolute protection from any rays whatever is a lead house which is covered on all sides, with the exception of the door, by a 2½ mm. lead layer and has large lead-glass windows through which to observe the tube and the patient. The dangerous primary rays may be thus avoided. Since it has become known that roentgen operators are frequently subject to blood anomalies, they should also strive to protect themselves from secondary rays, and this is done in the most perfect manner by the lead house. There are no secondary rays except those produced by the lead walls themselves, and they are the least harmful of all in the light of our present knowledge.

At the Roentgen Congress of 1913, the German Roentgen Society introduced a memorandum to be placed in conspicuous places of all roentgen institutions. [This has already been published in this journal.—Ed.]

As an example of absolute roentgen protection, as demanded by Albers-Schoenberg, a new institution has arisen in St. George's Hospital, Hamburg, in 1914-15, the protective arrangement of which will be described in the following:

a.—Protection from Unintentional Changes of Current.—The use of modern high tension rectifiers with a performance of 10 kilowatt and 150,000 volt, constitutes a source of danger, against which special precaution has been exercised in the new roentgen house. The leading idea was to exclude the possibility of a contact between the operator and the high tension cable. Of course, every trained operator will avoid such contact, but the real danger is not so much the direct contact, but the possibility of current being discharged at places where no work happens to be done.

b.—Protection from Roentgen Rays.—The protective measures for the physician and his staff against unintentional exposures are carried out in different ways in the various rooms. In the principal room for diagnosis and in the room for deep therapy, the principle of the protective house was adopted. In the room for surface therapy, protection is afforded by a box system arranged in the reverse manner, by placing the patient in a rayproof box, outside of which the physician directs the operations. The extraordinary power of penetration of mod-

ern tubes, especially in deep therapy, and with the new Coolidge tube, demand the greatest care in the construction of the protective houses. The protective structures of the new roentgen house are part of the installation and were not subsequently placed or built in when the rooms were finished.

Considering that the roentgen cases in a large hospital occupy many consecutive hours, absolute protection of the staff was an essential measure, the more so as with the necessary protective installation greater facility in the handling of the apparatus was achieved in the best possible way. The old view that protective houses are clumsy to work in, has not been confirmed; on the contrary, nearly all the modern institutions have adopted them. It can not be disputed, however, that certain roentgen procedures are not yet quite devoid of danger in spite of all our protective measures, as for instance exposure of the teeth and fluoroscopy. The best protection in these cases will be to shorten the exposure to the utmost or by giving the patient careful instructions how to hold the film himself. The patient will suffer less from a short transillumination than the physician who is constantly subject to them.

In regard to fluoroscopy, it will never be possible to obtain complete protection from secondary rays which emanate from the body of the patient. Even screens covered with a sufficiently thick layer of leadglass, allow slight quantities of hard rays to pass through, the persistent effect of which for days and years may lead to material injury. We hold the opinion that secondary rays, even in small quantities, are not without danger in continuous exposures, and that the blood production in particular is materially affected by them. The best possible protection is afforded by building the tube into rayproof boxes and to use leadrubber aprons, lead gloves and leadglass spectacles, etc. Still, it should always be remembered that the protection is not absolute and that in fluoroscopy particularly no more time should be spent in the work than is absolutely necessary.

In applying deep therapy, the protection for the physician is comparatively easy, because he need not leave the protective house during treatment. All the measuring instruments can be read off from his place of observation, and during the time he wishes to control the test strips, he will disconnect the tube. As a matter of course, the tube for both diagnostic and therapeutic purposes is always so placed that the direction of the rays is away from the operator.

The various auxiliary apparatus, compression diaphragms, transillumination boxes, trochoscope, tables, etc., are carefully earthed. This will prevent current entering the patient or operator in case of accidents. The high tension wire for the trochoscope runs close to the floor for technical reasons. Here a thick plateglass layer has been placed between the high tension and the floor, so that no current can enter into the feet of the operator working the trochoscope.

Roentgenography and Removal of Foreign Bodies in the Air Passages. **P. M. Hickey, M.D., Detroit, Michigan. (Read before the Michigan State Medical Society, Sept. 1 and 2, 1915.)**

As many of these foreign body cases occur in children, especially in young children, it is very important that the time of exposure for the roentgen plate be as short as possible. It is also advantageous to make use of the fluoroscope.

Anesthesia is a dangerous feature in these cases. It is much better, in the ordinary esophageal foreign body, if the child be securely wrapped in a sheet, as in preparation for intubation, and the obstruction removed without general anesthesia. The same rule applies to the removal of foreign bodies from the bronchi. While it may be urged that it is difficult to introduce the

bronchoscope without anesthesia in a young child, we would, however, insist that after the bronchoscope has been introduced no further anesthesia be given. In many cases the bronchoscope can easily be introduced without any general anesthesia. The maintenance of the cough reflex during the operation is a matter of importance in the prevention of aspiration pneumonia.

Another point in this particular is the tendency of children to develop acidosis after prolonged anesthesia. In many of these cases the search for the foreign body may have to be prolonged over a considerable period and, after the finding of the foreign body, the attempts at its removal may further prolong the time of operation. If during this long period the child is constantly inhaling ether, we think that the circumstances are very favorable for acidosis.

Intracerebral Pneumatocele after Shot Injuries. **L. Kredel, M.D. (Zentralbl. f. Chir., 1915, Sept. 4, No. 36, p. 649.)**

Intracerebral accumulation of air is a new pathological picture of war injuries. The first to observe this phenomenon after a gunshot wound was Duken (Münch. med. Woch., 1915, No. 17). [Dr. Wm. H. Stewart of New York reported a similar case in 1914.—Ed.]

After penetration of the frontal cavity and bone by a bullet, the external wound will heal, but the course of the bullet leaves an aperture which communicates direct from the frontal sinus with the brain, while the meningeal spaces remain closed up.

The natural tendency of the air to rise owing to its slight specific gravity is supported by physical efforts, sneezing, coughing, etc., which increases the upward pressure. This pressure is exerted upon a spot which was crushed and transanguinated by the shot. Consequently, these air accumulations are exceedingly large.

In roentgenograms, the enormous cavities can be easily recognized by large shadow defects. Two roentgenograms are reproduced, before and after operation.

Roentgen Treatment of Surgical Tuberculosis. **H. Denks, Hamburg. (Bruns Beitr., 92. Ref. Deutsche med. Wchnschr., 1915, April 22, vol. 41, No. 17, p. 509.)**

Of 323 cases, there were 43 fungous affections of the large articulations; 35% cured, 25.5% improved, 15% not cured, treatment discontinued, 23%.

Small articulations, of which 84% were cured and 10% improved. Large fistulæ 67, of which 50% were cured. Small fistulæ 54, with 60% of cures. In 11 cases of tuberculosis of the tendon sheaths, the results were less favorable, it being preferable to combine surgical with roentgen treatment. Of 18 cases of tubercular peritonitis, 16 underwent laparotomy and had roentgen treatment owing to relapses. Four were cured. Of 2 non-operated cases 1 was cured and 1 improved. Of 7 cases of tuberculosis of the bladder, in which the affected kidney had already been extirpated, 2 were cured and the other five improved. Ten relapsed cases of tuberculosis of the epididymis were improved. Of 101 cases of tubercular lymphoma 82 were cured.

On Radiotherapy of Hypophyseal Tumors. **Kuepferle and A. von Szily, Freiburg. (Deutsche med. Wchnschr., vol. 41, No. 31, July 29, 1915, page 910.)**

One of us (v. Szily) has pointed out on a former occasion (Kl. Bl. f. Aug., Vol. 52, p. 202) that the progressive loss of visual acuity and the field of vision to near the median line, or beyond, with a positive diagnosis of hypophyseal tumor, is a strict indication for surgical interference. Modern rhinological methods (Hirsch, Chiari-Kahler) are attended with a comparatively slight mortality which justifies this view.

However, we agree with Axenfeld, Wehrli (Kl. Bl. f. Aug., vol. 52, 1914, p. 653) and others that there are cases in which other methods are efficacious. In cases where a waiting attitude is permissible or when the central vision has already been lost, we do not advocate operation.

The conservative methods have of late been augmented by radiotherapy of hypophyseal tumors.

Patient was a retired business man 65 years of age.

June 30, 1913.—Bilateral atrophy of the optic nerves, bitemporal hemianopsia with incipient concentric reduction of the field of vision and hemianopic pupillary reaction. Visual acuity 6/20 R, 6/60 L. No general hypophyseal symptoms. Roentgen examination showed a distinct enlargement of the sella turcica.

July 15, 1913.—Operation on hypophysis by Prof. Kahler after the method devised by him in conjunction with Chiari. Total removal of the evidently malignant tumor was, of course, impossible. Vision on discharge 6/10—6/8 R, 6/36 L. Microscopic diagnosis: Endothelioma.

Things went well until the end of December, when vision gradually disappeared.

June 14, 1914.—Loss of central fixation, left vision reduced to counting fingers, right to movements of the hand before the eye. Lateral roentgen exposure showed renewed enlargement of tumor shadow.

Beginning of radiotherapy. At first the complaint increased, there being complete amaurosis in the beginning of July and loss of pupillary reaction. Nevertheless, radiotherapy was continued. Amaurosis lasted for two months. By the end of September rapid improvement set in on the right side almost up to the original condition (6/24), to the former field of vision and return of the pupillary reaction.

Vision has continued well for over 7 months.

Radiotherapeutic Technic.—It is difficult to reach the hypophysis deep in the cranial cavity and surrounded by thick soft parts. However, by dividing the available surface into a large number of ports of entry and selecting a sufficient hardness of rays, the tumor tissue should be amenable to treatment. With this reflection we marked 20 entrances, through each of which we applied 30 — 50 *x* of hard filtered rays, 2 places being rayed at each treatment. The central ray was directed toward the sella. The inferior surface, i.e., the sphenoid body, which partially forms the roof of the pharynx, being very difficult of access to the roentgen rays, a special radium carrier was constructed for the application of mesothorium. Thus we used a combination of rays: roentgen rays from without and mesothorium through the mouth. The principal advantage of radioactive substances consists in their closer proximity to the treated object. This combined treatment was continued for about 8 weeks, and the ultimate success was startling.

Bèclère (Strahlentherapie, 3, 1913, No. 2, p. 508) reports 4 cases and Gunsett (Strahlenther., 5, 1914, No. 1, p. 70) one case, in which pressure symptoms were similarly relieved. In these cases, roentgen rays were applied exclusively, and Bèclère treated his cases for many months with small surface doses. The favorable influence even in these cases coincides with our own observation that radiotherapy is a valuable aid in the treatment of hypophyseal tumors.

We shall henceforth resort to this method not only as an after-treatment to assure permanent success, but even as an independent measure in suitable cases.

A Roentgenological Phenomenon in Perforated Gastric Ulcer. W. Weiland. (Muenchen med. Wchnschr., 1915, No. 16.)

Farmer, 41. Constipation for 7 years, feces black. No stool for the last 2 weeks;

colicky pains. Vomited food remnants once, neither bloody nor malodorous. Decrease of weight.

Lower pulmonary borders displaceable with difficulty. Abdominal wall tense, slightly prolapsed, not painful to pressure. Loud tympanitic sound over entire abdomen, liver dullness not to be made out. No palpable tumor, no ascites. Nothing pathological per rectum.

Free HCl 70, total acidity, 95; much blood.

On rectal infusion, there was defecation consisting of almost pure blood.

Fluoroscopic Findings.—Large dilated stomach, high layer of secretion over barium paste which is still intact in the stomach after seven hours.—Two days later, colicky pains, liver dullness periodically in the right lateral parts. Several sanguineous defecations, no peritoneal irritative manifestations, distinct stiffening of the stomach on various occasions. On the following day, increase of abdominal tension. Possibility of perforation is considered. Between the right diaphragm, which is well displaceable on respiration, and the inferiorly displaced liver, there is an air-filled fissure in the shape of a scythe. A further study made after drinking a barium emulsion shows a very imperfect gastric outline with the remnants of old opaque meals. The opaque substance spreads in the abdomen according to the intestinal loops.

In the reclining position the liver is again close to the diaphragm. The clinical and roentgenological findings were interpreted as pointing to an encapsulated perforation of a gastric ulcer, located behind the liver and containing air.

Median laparotomy above the umbilicus. Loop of colon firmly adherent with the ligamentum teres to the anterior abdominal wall and then to the adjoining left hepatic lobe. Coarse infiltration at place of adhesion, continuing in a broad cord posteriorly on the lower hepatic surface toward the pyloric region. It is remarkable that a large loop of the transverse colon is located in the right subphrenic space, thereby considerably displacing the liver downward. Cutting through the adhesion between colon and liver, leads one into soft purulent granulation tissue. In the pyloric region, reaching to about the middle of the lesser curvature, there is an extensive fresh perigastritis with edematous infiltration of the wall. Immediately behind the pylorus, but in the duodenum, there is an ulcer at the posterior duodenal wall about the size of a half-dollar. Ulcer and pylorus firmly adherent to pancreas. The pyloric ring is permeable. Some yellow pus on palpation; abundant pus behind the pyloric region on introduction of dressing forceps. Drainage; gauze tamponage. Abdominal wound closed except for drainage.

Patient died from self-inflicted injuries, tearing out the drain and intestine.

Critical Remarks.—The assumption of an encapsulated abscess cavity proved wrong. We were misled because the first roentgen examination did not show a detachment of the liver from the diaphragm, and when it appeared, was accompanied by the clinical signs of perforation. The violent paroxysm of pain, the increasing abdominal tension, the conditions of temperature and pulse, and the positive presence of a pyloric ulcer had to be so interpreted. The stiffening was referred to the stomach. There were no other reasons for the detachment of the liver from the diaphragm. There were no symptoms of a perinephritic abscess, and a diaphragmatic eventration would have caused an elevation of the right half of the diaphragm. Hepatoptosis or "total detachment of the liver from the diaphragm with stretching and elongation of the fixation apparatus" (Faulhaber) was excluded, because such a condition did not exist at the time of the first roentgenologic examination. A partial prolapse with normal cohesion between liver and diaphragm

in the median parts was certainly not present in this case. In regard to total prolapse, Faulhaber says: "It has latterly again been doubted whether this condition really occurs. The diagnosis should be easy with the *x*-ray, because the intestine (colon) which usually contains air, can be recognized at a glance." In the present case, the air-containing medium between liver and diaphragm was clearly demonstrated, but it was not clear whether the colon enclosed the air-filled space. The findings were always alike, and in a colonic section this could not have been expected.

The roentgen findings, therefore, have to be interpreted as follows: The ulcer in the neighborhood of the pylorus led to perigastritis with inflammatory infiltration and pus collection behind the pylorus. The inflammatory process caused adhesions of the colon to the abdominal wall and liver, leading to a relative stenosis of the colon and a considerable distention of the proximal colonic section. The latter assumed a position behind and above the liver in the right subphrenic space, effecting a total separation of the liver from the right diaphragm, such as would correspond to the picture of a total hepatoptosis. The clinical course of the pathological picture of the perforating gastric ulcer led to the erroneous diagnosis of an air-filled encapsulated perforation behind the stomach having caused detachment of the liver.

Deep Roentgen Treatment in Carcinoma of the Stomach and Intestine. **Drs. Decker and H. von Bombard. (München. med. Wchnschr., No. 3, Jan. 10, 1915.)**

There are three ways whereby roentgen rays have been applied in the treatment of gastric carcinoma:

(1) through the skin;

(2) upon the muscles, after the skin has been dissected off above the tumor;

(3) upon the prolapsed tumor.

We have applied method No. 1 in 2 cases with positive results and No. 3 in 1 case with negative results. The latter method is very unpleasant for the patient. And since our success seems to show that results depend upon totally different factors than methods of application, the direct treatment of the skin seems to be preferable. It is also the most agreeable to the patient.

We have treated 21 cases of gastric and intestinal carcinoma with deep roentgen rays. The initial results were little encouraging. Some of the cases were too advanced to be benefited; others discontinued the treatment. Besides, the quantity of rays furnished by tubes of that time was so small that from technical reasons alone no favorable effect could be expected. Again, the interval between the various treatments was too long due to a fear of causing skin burns.

Following is a brief review of the favorable cases.

Case I.—B. J., restaurant keeper, 45 yrs. Admitted Feb. 16,' 1914.

Anamnesis:—Hereditary, n e g a t i v e. Stomach trouble for past 1 yr. and 9 mo. Pressure after meals. Vomited twice. Often serious pain in the gastric region. Anorexia, has repugnance to meat diet. Decrease of weight 30 lbs. in last 6 mo. Increasing inability to work for past year.

Condition.—State of nutrition, reduced. High degree of anemia (Hb 40%) and cachexia (116 lbs.). Heart and lungs, negative. Abdomen soft. In the left epigastrium a coarse, somewhat painful tumor, the size of a fist, a little displaceable. Filling defect at the pylorus extending far over the stomach.

Exploratory laparotomy showed a coarse carcinoma the size of a fist of the anterior gastric wall, extending into the pylorus and across the lesser curvature to the posterior wall. No resection done owing to extensive adhesions with liver. Gastroenterostomy is

not indicated. Closure of abdominal wound. After a week roentgen treatment commenced.

First treatment:—March 2-21, rays applied on 14 days for 20-30 minutes. Total quantity applied through the abdominal walls 405 X over 5 squares, so that the same square was rayed again every third or fourth day. No skin manifestations. Subjective recovery rapid, appetite slightly increased. Weight 118 lbs.

Second Treatment:—May 19-21, rays applied on 3 days for 20 minutes over 5 squares. Total 300 X. Weight 120 lbs. Subjective improvement continues, especially the appetite. No more pains. Filling defect diminished.

Third Treatment:—June 5-10, daily for 20 minutes over 8 squares. Total 570 X. Weight 123 lbs.

June 24 and 25, daily 20 minutes over 4 squares. Total 200 X.

Fourth Treatment:—July 9-11, 3 days for 20 minutes over 6 squares, total 300 X. Weight 128 lbs. Hb. 57%. The tumor can no longer be palpated as such. Filling defect now almost disappeared. The improvement shown by the roentgenogram was confirmed by palpation. At the end of the treatment the general condition is considerably improved, Hb. 70. Total quantity applied 1775 X.

The favorable effect proved that the carcinoma not only had made no progress, but had even undergone improvement.

Case II.—Mrs. W. A., 47 yrs., admitted April 27, 1914.

Anamnesis.—Gastric trouble for past 6 months. Pain in the gastric region, frequent vomiting, hematemesis, complete anorexia, rapid emaciation (lost 20 lbs. in last 2 months). Patient herself noticed a painful, palpable tumor in the gastric region.

Condition.—High degree of cachexia and anemia. Hb. 35%. Bedridden. Tongue dry with dirty coat, frequent vomiting, eructation. Test breakfast showed anacidity. Test meal leaves large quantities of coarse remnants.

Roentgenological. — Great filling defect in the pyloric part. Palpable tumor of the epigastrium, the size of a fist.

May 1.—Exploratory laparotomy. Large coarse carcinoma spreading from the lesser curvature to the anterior and posterior gastric wall. Resection of tumor impossible owing to its broad adhesion to the neighboring organs. Free ascites. Extensive glandular metastases along the greater and lesser curvature. Six days after laparotomy, beginning of roentgen treatment.

First Treatment.—May 6-15, 20 minutes daily over 4 squares, total 900 X. Each square is rayed every second day. No local manifestations. Patient feels weak after treatment. Slow improvement in general condition. Weight 95 lbs.

Second Treatment.—June 14-20, 20 minutes daily over 6 squares. Total 800 X. Weight 98 lbs. General condition much improved. Pains less. Appetite improved.

Third Treatment.—July 11-16, 20 minutes daily, over 6 squares (abdomen and back). Total 700 X. Weight 100 lbs. General condition very good. Tumor is considerably smaller. Total 2400 X.

The treatment has been a distinct success, to which patient undoubtedly owes her life.

Case III.—J. K., landed proprietor, 46 yrs., admitted March 17, 1914.

Anamnesis.—Father died of gastric carcinoma. Gastric trouble for past 6 months, pressure and stabbing pains in the gastric region. Much eructation. Bad taste in the mouth. Vomiting infrequent. Appetite very bad. Loss in weight 15 lbs. in 2 months.

Condition.—High degree of cachexia and anemia. Adipose tissue completely gone. Tongue dry, coated. Painful tumor the size of a large fist medially in the epigastrium.

First Treatment.—March 19-25, daily for

20 minutes over 8 squares. Total 575 X (abdomen and back).

March 26.—Exploratory laparotomy, free ascites. Carcinoma larger than a fist at the lesser curvature spreading to anterior and posterior surface. Close adhesions to neighboring organs, especially the liver. Extensive glandular metastases. Resection impossible. Abdominal wound closed.

Second Treatment.—Eight days after the operation, April 2-13. For 10 days, 10 to 14 minutes over 4 squares. Total 300 X. Each square was rayed again every third or fourth day. Locally no skin reaction. Patient feels very weak after the treatment. General condition unchanged. Appetite moderate.

On May 14 patient reported by letter that he is doing badly. Eight days after discharge, an abdominal inflammation set up which healed after ten days. Appetite and general condition bad. Was given up as lost. In the beginning of July, however, he returned to the sanatorium improved in appearance and with increased weight. Appetite very good. Pains practically gone.

The examination showed considerable pigmentation of the rayed abdominal skin (as is usually the case). Tumor still palpable, but much smaller. Fresh treatment instituted July 7-11. Total quantity so far applied 1375 X.

In this case, too, a favorable effect of the deep treatment must be assumed. Treatment is continued.

Case IV.—H. S., 56. Tenesmus for 1 yr. Diarrhea, sacral pains, hemorrhages.

Diagnosis.—Rectal carcinoma. In a number of treatments, 1600 X were applied, partly direct through the rectoscope, partly from the intestine, sacrum and nates. The last examination showed a moderate improvement, inasmuch as the two lower eminences of the tumor had disappeared. Treatment is continued.

In rectal carcinoma, the rays should not only be applied from the sacrum, but also direct. By the latter method the carcinoma is difficult to reach when located high up. The Strauss rectoscope which is used to determine the height of tumors is too long for the application of rays. The lead-glass tube which can be conveniently used in uterine carcinoma is useless in the rectum for want of direct illumination which is an indispensable requisite. The object could be accomplished by combining several small rectoscopes of 8, 10 and 12 cm. in length, but this would be a very cumbersome arrangement. For this reason Reiniger has constructed a telescopic rectoscope in accordance with our directions, which may be applied at 8, 10 or 12 cm. as required, with 3 corresponding illuminators. The instrument has been of considerable service to us.

Our cases show that the results improved with the use of harder tubes; so we may say that our experimental period is safely passed and that we may now expect very favorable results in the treatment of carcinoma, especially of the stomach and intestine.

The quantities we have administered varied between 1775 and 2400 X in a period of a few months, while Bumm and Warnekros have administered up to 3500 X in 3 weeks. Encouraged by these authors, we may assume that by applying such large quantities to gastric, intestinal and esophageal carcinoma in rapid succession, we shall arrive at much more favorable results.

In order to determine the relation of the rays penetrating from the surface into the deep parts, we introduced into the stomach a Kienboeck test strip enveloped in guttapercha and fastened to the end of a stomach tube with a thread. After 15 minutes' exposure, the strip showed 15 X. This experiment was repeated in rectal carcinoma, the test strip being introduced into the rectum and exposed from the coccyx for 10 minutes. Here again, a dose of 15 X was obtained. This, in our experience, is suf-

ficient to induce changes of the carcinomatous tissue which destroy the cells. We are quite aware of the fact that, according to our present photometric methods only one of numerous properties is determined, of which we do not even know the exact biological effect upon the human or carcinomatous cells. It is probable that the biological effect of the hardest roentgen rays is analogous to that of mesothorium. From the investigations made on microscopical changes of malignant tumor after mesothorium treatment, it appears that the changes are not specific, but necrotic, such as were known before after chemical or thermic effects, but to a much more intensified extent. There are two opinions on the nature of the effect produced:—

(1) The connective tissue formation is the primary effect. A tissue wall forms around the tumor which sends shoots into the inner parts, detaching several cell groups by constriction which would fall a secondary prey to necrosis. This opinion is only shared by a few.

(2) According to the other opinion which is held by the majority of authors, the real necrosis of the tumor cells is the primary occurrence and connective tissue will occur only secondarily after the phagocytes have removed the cellular débris. Whether according to this opinion there is a hypothetic connection with the proven fact that carcinomata with plentiful connective tissue react but slightly to the roentgen rays, and why such is the case, is a matter left for further elucidation. We have also been under the impression from our experience, that some carcinomata, especially scirrhus, are refractory to roentgen rays. Bumm and Warnekros dispute this, attributing the negative result purely to insufficient intensity. Further observations on this greater intensity will probably serve to clarify this important question.

We are hardly justified in assuming that the roentgen and mesothorium rays have a true elective effect, i. e., that among the existing cells they deliberately select the carcinoma cells, but rather that tumor cells are much less resistant to the rays and therefore more liable to destruction.

We have also used encytol injections, combined with roentgen treatment, but more extensive observations are necessary to form an opinion on their value. It so happened that in the favorable cases above described encytol had not been injected, but that is not conclusive.

Summary of Our Impressions:

(1) The small quantities of rays which have so far been applied are useless in deep-seated carcinoma.

(2) Larger quantities of hard roentgen rays, applied in quicker succession, have doubtless a destructive effect upon deep-seated (nonoperable) carcinoma.

(3) The formerly existing apprehensions about skin injuries due to this extensive application of rays seem to be unfounded.

(4) On the ground of this experience, it is incumbent upon us in every case of inoperable gastric or intestinal carcinoma to apply the most intense roentgen therapy.

A Method of Measuring the Quantity and Quality of Roentgen Rays. **Ernst v. Seuffert. (Deutsche med. Wchnschr., July 1, 1915.)**

The most reliable method of measuring rays which is free from scientific objections is that effected by ionization.

The State Testing Laboratories (Physikalish-Technische Reichsanstalt of Charlottenberg; K. K. Radium Institute of Vienna) are using this method almost exclusively.

The iontoquantimeter of Szilard, made by Reiniger, G & S, enables every roentgenologist to undertake ionization measurements of any roentgen apparatus.

The first to call attention to this instru-

ment was Th. Christen, who wrote a monograph on the subject. The original form there described was still provided with the empirical scale adjusted for medium hardness in Kienboeck's units. The latter instruments are adjusted on the absolute unit "mega-megaion," proposed by Szilard, the principal advantage of which consists in the fact that it furnishes absolute physical values for all degrees of hardness under conditions to be referred to presently.

The translation of Szilard's original publication is contained in Strahlentherapie, vol. V, p. 724, and a detailed review of the Iontoquantimeter by Hans Meyer is found in the Zentralblatt f. Gyn., 1914, No. 47.

Iontometry is based upon the fact that by absorption of certain rays, air is ionized and thereby becomes a conductor of electricity.

The ionization chamber of Szilard's instrument contains precisely 1 c. c. of air. This air space is connected by a well insulated conductor, with an electrometer which may be adjusted for a definite potential. The ionization chamber has a window 1 cm. sq., of very thin aluminum, through which the rays enter, ionizing the 1 c. c. of air and transforming the same into a conductor. Consequently the electrometer will discharge more or less rapidly according to the intensity of the ionization. The energy required for the discharge from 0 to 1.0 of the scale amounts to $10.^{12}$ ions or 1 "mega-megaion."

The object is to measure the time required to produce by means of the rays under investigation in the ionization chamber this 1 mega-megaion which, at the particular tension of the electrometer, effects just this discharge from 0 to 1.0.

This time is in inverse proportion, but the rapidity of the discharge in direct proportion to the quantity of the rays absorbed in the ionization chamber.

The quantity of this absorption is again in direct proportion to the total quantity of rays which enter the chamber (superficial intensity) and in inverse proportion to the power of penetration (hardness) of these rays, because rays of high penetration (hard rays) are less absorbed than those of less penetration (soft rays). For instance:—

Supposing the discharge is effected in a relatively short time, this may be due to one of two causes:—

(1) Either a relatively small quantity of soft rays has entered the chamber, a very large percentage of which is absorbed, causing a high effect of ionization; or

(2) A very large quantity of hard rays has entered the chamber, of which only a small percentage is absorbed which, however, on account of its large quantity is sufficient to effect a rapid discharge.

If the rays are qualitatively homogeneous, i. e., if they consist exclusively of rays of equal penetration, the absorption coefficient of which is known, the time of discharge indicates directly the total quantity of rays. Such is practically the case with pure gamma rays. The quantity so determined may be expressed either in the absolute value of mega-megaions, or relative values can be obtained by comparison with a standard or any other object of comparison.

But if there is a mixture of rays of variable penetration, as is always the case with roentgen rays, further measures are needed to establish the total quantity and the percentage effect of each quality of rays. The principle of the test will then be as follows:—

The time of discharge is established by unfiltered rays, after which various filters are inserted in succession.

If through filtration the ionization becomes rapidly weaker, and the time of discharge therefore prolonged, it shows that the ionization effect of the unfiltered rays was effected by a relatively large quantity of soft rays which had already been eliminated by weak filters.

If on the other hand, in spite of strong filtration, the original time of discharge is only slightly prolonged then the initial ionization was likewise effected, entirely or nearly so, by hard rays which, in contradistinction to soft rays, continue to exert their ionizing effect almost unweakened by strong filtration.

In this way it is possible by the selection of suitable filters and slowly increasing the filter effect, to gradually reduce any mixture of rays into its component parts and to establish the participation of their percentage. The absolute or relative values mentioned above are finally deduced by simple calculation.

This "filter analysis" of roentgen rays will probably be more useful for the purpose of radiotherapy than the spectral analysis which has still to overcome great difficulties.

The following points, however, should still be observed for inconstant sources of light, i. e., in all forms of roentgen rays.

All measuring methods intended to establish the qualitative composition can only furnish useful values, if in all tests of a series, with or without filters, the working conditions (hardness of tubes, current, etc.) of the identical apparatus are absolutely the same, because only in that case is there a certainty that any variations in the ionization are exclusively produced by the filter then in use, and not to changes in working conditions, such as the hardening or softening of the tubes.

In testing roentgen rays, it is necessary to work simultaneously with at least two iontoquantimeters (preferably similarly charged) in the following manner:—

The rays entering into the ionization chamber of one of the quantimeters are changed by filtration. The chamber of the second, or control instrument, must be rayed under the same conditions in all of the tests, that is to say always unfiltered or always filtered in the same way. As long, then, as the roentgen apparatus works evenly, the time of discharge of the control quantimeter must likewise always be the same.

As soon, however, as there is a change in the working conditions, say the hardness of the tube, this will at once be seen in the control instrument which will indicate a similar change in discharge. The test is therefore useless and has to be repeated under proper conditions.

In order that both chambers, that of the main quantimeter and that of the control quantimeter, should receive absolutely uniform radiation, the following points must be observed:—

(1) The two chambers must be placed at both sides of the anode-cathode line of the tube—not one chamber under the anode half and the other under the cathode half, because only the rays of both lateral halves of a tube are uniform.

(2) The tube must be accurately centered between the two chambers.

The following points, which are likewise to be observed, are of the same importance in every determination by ionization.

a.—The rays must enter exclusively through the windows of the ionization chambers. When hard rays are used, even careful insulation of all quantimeter parts is not sufficient. The following protective measures are necessary.

b.—The temperature and moisture of the room should be as much as possible alike in all comparative tests.

c.—Any foreign ray effect (possibly by radioactive substances in the neighborhood) must be excluded.

d.—The iontometers must be grounded and firmly and accurately set with the aid of their water levels.

The following is a description of the devices which have given good results at my hands.

The iontometer boxes and the operator are behind one of the usual protective lead

screens with lead glass windows. The rubber tube connections are encased in flexible lead tubes 2 to 3 mm. thick from the place where they leave from behind the protective screens to their point of entry under the top of the *x*-ray table.

Such a table can be easily made by any carpenter. It consists of a top 150 cm. long and 50 cm. wide, upon which two longitudinal boards 2 cm. thick (corresponding to the height of the ionization chambers) are so fixed, that the ionization chambers together with the distal ends of the connecting rubber tubes may be placed and fixed between them. A lid, covered with at least 3 mm. lead and provided with four handles, covers up the whole arrangement except the two chamber windows. Tests with gamma rays of radioactive substances, however, require a considerably stronger lead protection.

The four vertical wooden legs support the roentgen tube with or without a protective box. They also carry the devices for the accurate fixation of the tube for distance and centering.

All kinds of filters, even very thick ones, such as thick pieces of meat, may be simply inserted between the tube and the ionization chamber without changing the distance. The latter, however, should not be too short. Thus, the conditions of dispersion will always remain the same, facilitating the calculation considerably.

To determine the exact volume of meat filters, drawers of thin celluloid plates with accurate light measurement are used. Without exerting undue pressure the boxes are filled with a piece of meat, which is rather too large, the overlapping parts being carefully trimmed off. The lid and bottom may be removed during radiation, as the lateral walls are sufficient to hold the meat in position. But in view of the minute absorption coefficient of celluloid, the lid and bottom, even if left in position, would not affect the result.

The author will report later on more extensive experiments. A table, however, is appended showing interesting results obtained in experiments for comparison with three of the most modern apparatus.

This table speaks so eloquently that on the strength of it a decision can at once be arrived at as to which of the three instruments is most suitable for a given purpose. The best proof for the correctness of these theoretical considerations is that they have been extensively verified in practice.

Increased technical requirements are demanded in cases, for the treatment of which the ordinary hard and very hard roentgen rays are qualitatively sufficient, but only in very small quantities.

For carcinoma, according to the author, not only large doses of hard rays are necessary, but also of a certain quality, which so far has been found only in radioactive substances. Rays are needed whose penetration will equal or at least closely approach that of the gamma-rays of radium C or mesothorium. To test roentgen rays for this capacity is not difficult. Gamma-rays penetrate lead, about 1 cm. thick, roentgen rays of equal hardness must consequently also penetrate the lead filter.

Surface Therapy with Large Doses of Highly Filtered Roentgen Rays Especially in Cancroids and in Hypertrichosis. A. Gunsett. (Strahlentherapie V. No. 1, p. 219.)

The effect of filtered rays is now also being tested for surface skin affections. In the beginning of roentgen therapy, Freund and others reported good results chiefly with hard tubes, but later and up to the latest times, the medium rays are considered best for skin affections. Latterly, however, eczema, psychosis, lupus, cancroids—which did not do well with soft rays—have been very successfully treated through an aluminum filter of 0.5-1 mm. Hypertrichosis and can-

croids have been treated with brilliant results recently by French authors.

Gunsett has reëxamined these statements made by Nogier and Regaud. Under a 4 mm. aluminum filter slight erythema will only appear with about 40*x*. There is no injury to the skin. With this treatment, Gunsett believes the result will be more permanent than formerly.

His therapy in hypertrichosis is as follows: The face is divided into three areas, each of which receives 40*x* under 4 mm. aluminum. Erythema appeared in two weeks and all the hair fell out. The erythema was rather painful; after six weeks there was but slight pigmentation left. Gunsett is rather careful in his remarks about late atrophy. He reports in a P. S. that he has now achieved success in a case of lupus erythematodes which had so far defied all his efforts.

The Irritative Effect of Roentgen Rays in Struma and Basedow's Disease. **Robert Kienboeck. (Fortschritte a. d. Geb. f. Roentgenstrahlen, vol. 22, No. 5, p. 501.)**

Roentgen treatment of struma has often been followed by redness, numbness, perspiration, high frequency of pulse, diarrhea, fever, etc., due probably to conditions of the internal secretion or general conditions of thyroidism. After these by-effects have disappeared, reduction of the struma and a condition of general well-being sets in. The reduction may even commence before the general irritation has subsided. In exceptional cases, however, thyroidism may persist for a very long time. In this connection, Kienboeck and Decastello had previously reported the case of a 68-year-old woman in whom the reaction persisted for over a year, while the struma itself underwent reduction. It would appear that here there was a prepared soil specially susceptible to the disease outside the thyroid, so that a transitory irritation of the thyroid was sufficient to provoke the affection elsewhere.

These observations show the initial treatment should be slow and careful, and that energetic treatment is only permissible if after the lapse of several weeks no serious irritative manifestations have set in. Roentgentherapy is certainly indicated in all forms of struma, including the large cervical and substernal. *X*-ray treatment in Basedow's disease may also give rise to manifestations indicative of an exacerbation. Kienboeck details three of such cases, two of which were fatal. These patients, however, had already been given up before *x*-ray treatment commenced. They were cases of Basedow after iodine. Kienboeck urges very slow procedure in the *x*-ray treatment of Basedow's disease, with periodical intervals.

Early Recognition of Gas Phlegmons by the Roentgen Organ. **Ludwig Finck. (Deutsche med. Wchnschr., 1915, No. 20, p. 585.)**

There are two forms of gas phlegmons: (a) the malignant form, progressive with gas formation and the danger of gangrene in large tissue sections; (b) the milder form, retention of secretion and decomposition with gas formation surrounding a foreign body, and not progressive at first. These latter cases may escape the patient as well as the physician, but are easily demonstrated by the roentgenogram. Deep in the vicinity of the foreign body there is a small dark spot, i. e., a tissue gap with round contours, which the trained eye will immediately and positively recognize as an air bubble.

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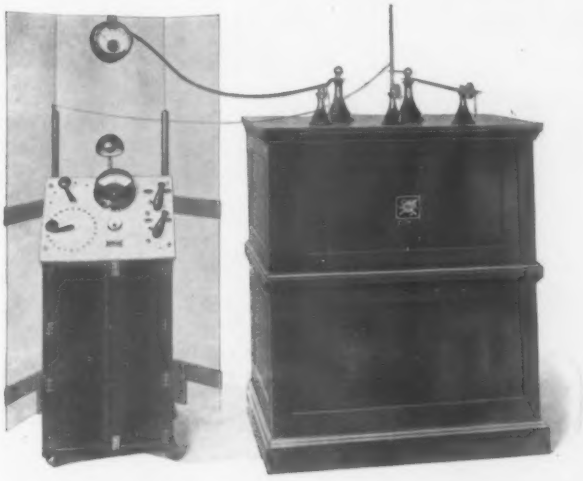

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